Aloha Partners, L.P.
4 Richmond Square, Suite 330
Providence, R. I. 02906
Tel: 401-458-1900, Direct: 401-458-1901, Fax: 401-458-1998
e-mail: ctownsend@hiwire.net

June 20, 2008

Julius Knapp, Chief
Federal Communications Commission
Office of Engineering and Technology
445 12th Street SW
Washington, DC 20554

RE: ET Docket No. 04-186

Dear Julius:

Tom Gutierrez and I genuinely appreciate the time that you and your staff spent with us earlier this week.

I have attached the data that you requested. The enclosed charts summarize the Brattle Group study of White Space potential that was submitted in January 2007. This study indicates that between 12-48 MHz of White Space will be available in the top 10 MTA's (even if adjacent channels are protected for the broadcasters' Class A stations and translators). The Brattle Group study also indicates that at least 100 MHz of White Space will be available in the rural areas (even if adjacent channels are protected for the Broadcasters Class A stations and translators). This is the Brattle Group scenario Z.

The enclosed charts address your question about what impact protecting adjacent channels will have on available White Space in the top 10 markets. The available White Space in the top 10 MTA's is reduced from an average of 125 MHz of White Space without adjacent channel protection to 25 MHz with adjacent channel protection. This is the difference between scenario X and scenario Y.

Finally, the enclosed charts address your question about the impact of protecting LPTV stations. The Brattle Group included 7,315 translators in their analysis in scenario Z. (I do not know if this number includes all the LPTV stations). In order to answer your question we subtracted the results in scenario Y (Broadcast stations only) from scenario Z (Broadcast stations + translators). Based on this data, translators have a minimal impact in the top 10 MTAs, reducing available White Space from an average of 26 MHz to 24 MHz. In the next 20 largest MTAs (11-30), the impact is also minimal, reducing average available White Space from 55 MHz to 53 MHz. Only in the rural areas is there a significant reduction of White Space due to the inclusion of translators. The available White Space in rural areas is reduced from an average of 120 MHz to 100 MHz. However, 100 MHz is still plenty of spectrum to accommodate several Wireless Broadband operators.

The first attachment is the full Brattle Group analysis.

You asked that we provide you with our perspective on the White Space proceeding in the United Kingdom. The British appear to be farther along than we thought. I have attached several documents (Attachments 2 and 3) which were recently released by OFCOM. These documents indicate that the British appear to have already established White Space rules and plan to both license and auction this spectrum. The British also will not protect adjacent channels, but will require a small guard-band.

We have quantified the propagation advantages that licensed spectrum offers in rural areas compared to unlicensed spectrum. Based on a typical licensed power of 1kW for the licensed spectrum versus 1 W for the unlicensed spectrum, we estimate that a licensed signal can travel up to 30 miles and an unlicensed signal can travel up to 4 miles. This difference results in over a 50 to 1 coverage advantage for the licensed spectrum. This propagation advantage will result in a huge cost advantage for licensed networks compared to unlicensed networks. Two years ago, NTCA surveyed its membership about their preference for licensed versus unlicensed spectrum. Of rural telephone companies that were using unlicensed spectrum “75% would prefer access to additional licensed spectrum over additional unlicensed spectrum.”

Finally, you asked for our perspective on the applicability of the existing adjacent channel interference rules to the White Space. As you pointed out, how the White Space is used has a significant impact on the potential for adjacent channel interference. The Broadcasters have established a rigorous adjacent channel interference methodology that calculates whether adjacent channel interference is acceptable or not from other broadcast signals. QUALCOMM has had numerous waiver requests approved for Mobile TV applications on Channel 55 using this methodology. We believe that this same methodology could be used in the White Space for Mobile TV applications.

In the 700 MHz auction NPRM, the Commission established rules for adjacent channel interference from 2 way broadband networks to broadcast channels at the channel 51 and 52 interface. We believe that those same rules should be made applicable to the White Space channels. Several years ago, Aloha conducted a test in Phoenix of adjacent channel interference between a 2 way broadband network and the adjacent broadcasters. Aloha had licenses for Channels 54 and 59. Aloha found that the area that adjacent channel interference was most likely to occur was at the periphery of the broadcast Grade B Contour where the broadcast signal was the weakest. Through the use of filters and power reduction in those areas, Aloha was able to minimize adjacent channel interference to levels that would be in compliance with the existing rules.

After reviewing all of this information, we reached a number of conclusions:

1) Significant White Space will be available for licensing and auctions, even under the most stringent interference protection rules;
2) Rules already exist for addressing adjacent channel interference, and they should be applied to the White Spaces. The Commission established rules for 2 Way Broadband networks in the 700 MHz NPRM for the channel 51 and 52 interface;
3) QUALCOMM has consistently demonstrated that the existing Broadcaster adjacent channel interference methodology is applicable to Mobile TV applications;
4) The U.K. has assessed White Space and appears to have concluded that adjacent channel interference is manageable and that licensing and auctions are preferred; and
5) Licensing spectrum is a critical element to providing wireless broadband to unserved broadband regions. Licensed spectrum will cover a 50 times greater area than unlicensed spectrum. Licensed spectrum is the only way to make wireless broadband economically viable in low population density areas.

Thanks again for your time and comments. Please call me at 401-458-1901 if you would like any additional information.

Very truly yours,

_______________/s/____________
Charles Townsend

Attachments

Key Conclusions from Brattle Group Analysis

- There is at least 24 MHz of White Space available in most major markets, even if adjacent channels and translators are protected.
- Mid-Sized markets and rural areas have 50-100 MHz of White Space available , even if adjacent channels and translators are protected.
- Protecting Adjacent Channels will reduce useable spectrum by up to 100 MHz.
- Protecting translators has little impact on large markets(-2 MHz of spectrum)
- Protecting translators in rural areas reduces useable spectrum by -20 MHz, but still leaves 100 MHz available for rural broadband.

Brattle Group Analysis
Summary

Top 10 MTA's

Clear Spectrum Analysis

		Scenarios		
MTA #	Name	Co-Channel Only Scenario X	Co+Adj Channel Scenario Y	Co+Adj Ch+Translators Scenario Z
1	New York	78 MHz	18 MHz	18 MHz
2	Los Angeles	108 MHz	12 MHz	12 MHz
3	Chicago	114 MHz	18 MHz	18 MHz
4	San Francisco	78 MHz	12 MHz*	12 MHz*
5	Detroit	120 MHz	24 MHz	24 MHz
6	Charlotte	150 MHz	30 MHz	24 MHz
7	Dallas	156 MHz	54 MHz	48 MHz
8	Boston	108 MHz	48 MHz	42 MHz
9	Philadelphia	78 MHz	12 MHz	12 MHz
10	Washington	120 MHz	30 MHz	30 MHz
Top 10	Average	125 MHz	27 MHz	23 MHz
Top 11 - 30	Average	160 MHz	55 MHz	53 MHz
Rural Markets	Average	225 MHz	120 MHz	100 MHz

Note: * Represents 95% availability

Attachment 1

Before The
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In The Matter Of	)	
Unlicensed Operation in the TV Broadcast Bands	)	ET Docket No. 04-186
Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band	)	ET Docket No. 02-380

To: The Commission

Comments of Charles L. Jackson and Dorothy Robyn

Charles L. Jackson
5210 Edgemoor Lane
Bethesda, MD 20814
(301) 656-8716 (v)
(301) 656-8717 (f)
chuck@jacksons.net

Dorothy Robyn
The Brattle Group
1133 20th Street, NW
Washington, DC 20036
(202) 419-3304 (v)
(202) 955-5059 (f)
dorothy.robyn@brattle.com

The authors are grateful to QUALCOMM for its support of this study.

Dated: January 31, 2007

SUMMARY

The TV White Space

Although broadcasting will occupy 17 fewer TV channels than it does today after the transition to digital television (DTV), substantial unused but useful radio spectrum will remain in the TV bands. This spectrum, known as white space, resembles Swiss cheese—it is a large block of spectrum with "holes" where the TV signals must be protected from interference.

Policy Choice

The FCC can choose among three different approaches to managing this white space: (1) allow the white space to continue to lie idle, (2) permit unlicensed use of the white space, or (2) auction off flexible, tradable rights, or licenses, to the use of the white space. Unfortunately, much of the debate to date has focused on the possibility and details of unlicensed use; licensed use has remained the unexamined alternative.

Commendably, the Commission has now formally expanded its proceeding to include consideration of a licensed approach to use of the white space (Option 3). The purpose of our analysis is to better define this third option and to evaluate its benefits relative to those of an unlicensed approach (we discard Option 1 as wasteful).

Extent of White Space

- Under interference-protection rules appropriate to a licensed regime, 97% of the population lives in locations at which there will be at least 24 MHz of spectrum available in the white space following the DTV transition.

- There is dramatically less (about half as much) spectrum available in the white space under interference-protection rules that correspond to those the FCC is most likely to impose in an unlicensed regime.

Drawbacks to Unlicensed Use of the White Space (Near Term)

- For short-range data transfer, unlicensed TV spectrum would be inferior to the existing unlicensed bands at 2.4 GHz and 5 GHz. A combination of limited data rates, network externalities, and added costs to avoid interference with incumbents will impede adoption of this band for the market needs served by today's wireless local area networks (LANs).

- Similar factors fatally impaired the unlicensed PCS (UPCS) band. Although unlicensed white space (unlike UPCS) would attract users, the likely short-range applications would not add significant value beyond those found in existing unlicensed bands today.

- Investment in long-range applications would be impeded for a different reason—the threat of interference, including that from short-range wireless LAN operations in the white space. The FCC's ongoing 3.65 GHz proceeding supports the view that lack of exclusive rights discourages investment in long-range infrastructure.

- In addition to offering limited incremental benefits, an unlicensed regime would impose a large opportunity cost by precluding licensed use of the white space. This is a key difference between the white space and the oft-cited 2.4 GHz band, and something that unlicensed advocates have systematically ignored.

- As one source of this opportunity cost, the white space is "overqualified" for the low-power, short-range wireless networks that unlicensed advocates envision; it would amount to using land in downtown Tokyo to grow rice.

Advantages of Licensed Use of the White Space (Near Term)

- Licensed access creates the incentive and opportunity for white-space licensees and broadcasters to engage in negotiations to expand licensed service. Such Coasian bargaining could produce variances beyond the FCC interference standards—standards that themselves would be less protective in a licensed regime.

- Those two factors (bargaining plus less protective standards) should result in substantially more white space being used than in an unlicensed regime. (Our calculation of available white space captures only the latter.)

- By controlling interference, licensed access provides better incentives for the provision of long-range services, such as wireless Internet access, for which this spectrum is particularly well-suited. Thus, a licensed approach is far more likely to produce the large investments in long-range infrastructure that rural broadband requires.

Long-Term Impact of Unlicensed versus Licensed

- Whatever its short-run contribution, unlicensed access would impede the long-term transition of the TV band to higher value uses by creating a constituency of spectrum "squatters" and their suppliers. In this way, an unlicensed regime would perpetuate the current regulatory system's tendency to encourage rent-seeking and discourage entrepreneurial innovation.

- In principle, one could use technology to moderate the effects of the squatter's rights problem. But it would require political will to impose a technological solution—an unlikely scenario.

- By contrast, a licensed approach would facilitate the evolution of the TV band. If broadcasters were given flexible use rights, over time, broadcasters and white-space licensees would reengineer the broadcast system, freeing up most of the spectrum for higher value uses.

Feasibility of a Licensed Approach

- To the limited extent that they have acknowledged the licensed alternative to white-space access, unlicensed advocates have dismissed it as infeasible on the grounds that the transaction costs of dealing with spectrum "Swiss cheese" would be prohibitive.

- But transaction costs are an issue only because licensed operations would make more extensive and efficient use of the white space through frequency coordination and interference negotiation. A white-space licensee could always eliminate transaction costs by using the white space in the same, limited way that unlicensed advocates propose.

- Moreover, contrary to the claims of unlicensed advocates, those coordination activities need not be prohibitively complex or costly. The FCC typically structures overlay licenses with an eye to limiting coordination costs, and structuring licenses for the white space would not be fundamentally different.

Potential Auction Revenues

- The revenues from the auction of white-space spectrum could be substantial. Using two different market comparables, we estimate that white-space auctions would yield between $3.7 billion and $6 billion.

I. INTRODUCTION

Television broadcasters occupy a large band of spectrum that is considered highly desirable largely because of its superior propagation characteristics. Although broadcasters will relinquish 17 UHF channels (channels 52-69) as part of the digital television (DTV) transition, the post-transition TV band (channels 2-36 and 38-51) will still represent a large swath (294 MHz) of choice spectrum.

In some geographic areas, substantial blocks of the TV band are essentially vacant—*i.e.*, not encumbered by existing licensees—and that pattern will persist following the DTV transition. However, estimates vary as to how much of this vacant TV spectrum ("white space") there is now in different locations, and how much will be left following the DTV transition.

Although white space was traditionally considered unusable, developments in digital technology mean that this valuable spectrum can now be put to productive use. There are three basic options for managing the TV white space in a post-DTV environment. Option 1 is to leave it fallow. Option 2 is to make the white space available for non-interfering, low-power devices on an unlicensed, or commons, basis. Option 3 is to make it available under a flexible and tradable license that would protect incumbent license-holders (primarily broadcasters) from interference.

Remarkably, the debate over TV white space has until recently been limited to the first two options: leave the white space idle (*i.e.*, status quo) versus allow unlicensed access. Proponents of the second option have argued that unlicensed devices could identify the vacant spectrum and use it to provide valuable new wireless applications that would generate substantial consumer benefits. Broadcasters, asserting that such devices would interfere with their over-the-air signals, have staunchly defended the status quo policy on white space (no access). The debate over these two choices has focused largely on technical issues related to whether unlicensed devices would in fact create harmful interference.

Commendably, the Commission has now formally expanded its proceeding to include consideration of a licensed approach to use of the white space (Option 3). The purpose of our analysis is to better define this third option and to evaluate its benefits relative to those of an unlicensed approach (we discard Option 1 as wasteful).

We focus on the relative economic benefits of licensed versus unlicensed access to the white space, in the belief that spectrum allocation is, ultimately, an economic policy choice. We ignore the technical question of whether an unlicensed approach would create harmful interference, on the assumption that the FCC could find a way to implement such an approach that would control interference. (A licensed approach, by definition, would control interference.) That said, we do take into account the fact that the choice of approach—licensed versus unlicensed—would affect the amount of TV white space available for use (and, in fact, we quantify that effect).

Our report is organized as follows. In Section II, by way of background, we summarize the broader debate over the appropriate mix of spectrum management models—command and control, property rights and unlicensed commons. In Section III, we present the results of our own analysis of a threshold, technical question: How much white space will be available in the

TV band following the DTV transition under different scenarios? In Section IV, we critique the case for unlicensed access to the TV white space and examine key effects of such an approach. In Section V, we make the affirmative case for licensed access; among other things, we estimate the potential revenue that an FCC auction of white-space spectrum rights would generate.

II. ORIGINS OF THE WHITE SPACE DEBATE

The FCC's traditional, highly regulatory approach to limiting spectrum interference—a legacy of the technologies and communications needs of the 1920s and 1930s—is a source of significant waste and inefficiency in our digital age. The litany is familiar: Restrictions on the use and transferability of licenses keep valuable bandwidth locked into the provision of low-value services and encourage hoarding of spectrum. Over time, these restrictions depress the incentives for innovation and delay the introduction of valuable new technologies. An innovator who wants to bring a new technology to market often has to wait years or even decades for the FCC to make the necessary changes in the spectrum rules and allocations, and in the process reveal proprietary business ideas to potential competitors. Although the Commission has reformed key elements of this obsolete regime, much spectrum remains tightly regulated.

The same forces that discourage innovation promote rent-seeking. Firms spend large resources on lawyers and lobbyists in an effort to influence the market-shaping decisions of regulators and their congressional overseers. And the playing field is not level. As with other Depression-era "public interest" regulatory regimes, spectrum regulation has often protected incumbents and other special interests from competition. Among other things, often broadcasters "play the interference card" to oppose the entry of potential rivals and others seeking to use adjacent spectrum.[1]

A. Property Rights versus Unlicensed Commons

Although there is a broad consensus that the command-and-control regulatory regime should give way to a more flexible, decentralized approach to spectrum governance, there is less agreement on what that approach should be. The debate has revolved around two competing, but not necessarily mutually exclusive, visions—a market approach that treats licensed access to the spectrum as private property, and a commons approach that eschews licensing altogether.

Economists, who have long been skeptical about the ability of government agencies to "pick winners," have preponderantly favored a market approach to the allocation of resources, generally, and spectrum, in particular.[2] As early as 1959, Ronald Coase wrote that spectrum was a fixed factor of production, like land or labor, and should be treated in the same way, with its use determined by the pricing system and awarded to the highest bidder. In an analysis of FCC regulation that led directly to his Nobel-winning essay the following year, Coase concluded

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[1] Jonathan E. Neuchterlein and Philip J. Weiser, *Digital Crossroads: American Telecommunications Policy in the Internet Age* (MIT Press, 2005), p. 240. Broadcaster concerns with interference are often legitimate. However, under FCC rules, broadcasters cannot sell or lease adjacent spectrum or negotiate over its use; thus, their incentive is to take the most conservative possible stance regarding the threat of interference.

[2] William J. Baumol and Dorothy Robyn, *Toward an Evolutionary Regime for Spectrum Governance: Licensing or Unrestricted Entry?* (Brookings Institution Press, 2006), pp. 9-14.

that the assignment of well-defined property rights in spectrum use that such an allocation would entail would be sufficient to prevent inefficient broadcast interference.[3]

The market-based approach to spectrum governance has two important advantages over traditional licensing. The first is *efficiency in use*. Economists believe that the profit motive will deliver spectrum, like any other valuable resource, to those who can put it to the uses most desired by the public. Over time, the inexorable pressure to make efficient use of a scarce resource, such as spectrum, leads to increased investment and innovation; this *dynamic efficiency* is a second important advantage that markets provide relative to administrative licensing.

Although the FCC has traditionally allowed some role for the market in spectrum management (*e.g.*, radio licenses have long been bought and sold), that role expanded markedly in 1993, when Congress authorized the use of auctions to award (some) spectrum licenses—an approach that every American president since the 1970s had advocated. The FCC has auctioned off most new exclusive spectrum licenses since then, and it recently took steps to promote a secondary market in spectrum rights. Although these changes represent a big improvement on administrative licensing, only a fraction of the most valuable spectrum is subject to market-based management.

At the same time that market-based reforms to spectrum regulation were gaining wider acceptance, some legal scholars and a handful of firms (*e.g.*, Apple Computer) were urging the FCC to eschew licensing altogether and treat the spectrum, or large blocks of it, as a common resource, or commons.[4] The Commission had traditionally allowed certain bands to be used by anyone who transmitted with equipment that met certain specifications; as of 1996, about 200 MHz of spectrum was designated for such unlicensed use.[5] Since then, the FCC has set aside a significant amount of additional spectrum for unlicensed use, and several of these unlicensed bands have generated widespread use. The most prominent use of unlicensed spectrum is wireless computer networking—specifically, wireless local area networks (WLANs, or LANs), including Wi-Fi and Bluetooth devices. The popularity of these applications has generated broader support for a commons (or unlicensed) approach to spectrum governance.

Proponents of a commons approach base their case primarily on recent and anticipated developments in technology. They note that the "amount" of spectrum that many new uses require is minimal and newer receivers can adapt to the presence of interference at levels that

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3 Ronald H. Coase, "The Federal Communications Commission," *Journal of Law & Economics* 2 (1959).

4 Commons proponents are as critical of administrative licensing of spectrum as are economists, but for a different reason: whereas economists oppose the use of *regulation* to assign the licenses and restrict their use, commons proponents oppose *licensing*—i.e., the *exclusive assignment of frequencies*. From their perspective, moreover, a market approach to licensing represents little if any improvement on administrative licensing.

5 FCC staff proposed such flexible bands as early as the late 1970s. In the mid-1980s, the FCC adopted liberal rules permitting the use of spread spectrum radio systems on an unlicensed basis at 902-928, 2400-2483.5 and 5725-5850 MHz. Over time, the rules governing these and other unlicensed bands have been relaxed to permit the use of any digital modulation, not just spread spectrum, subject to limits on power and power density. The FCC's current, more relaxed rules are similar to what FCC analysts proposed three decades ago. See C. Jackson, "The Allocation of the Radio Spectrum," *Scientific American*, Vol. 242, No. 2 (February 1980).

would have caused traditional technologies to fail. Thus, there is said to be little or no need for the imposition of exclusivity to prevent serious interference. As important, licensing is said to be impractical because the transaction costs of arranging to get the necessary spectrum rights for this newer technology would exceed the benefits. For example, the spectrum used by a keyless automobile door lock control would be worth only a few hundredths of a cent.

Although the proponents of a commons regime reject the exclusive assignment of spectrum rights that is essential to the market approach, they maintain that a commons approach would nevertheless harness market forces by facilitating the operation of a market for end-user equipment. According to this argument, it would be in the interests of manufacturers of unlicensed spectrum-using equipment to invest in designs that performed robustly in the presence of interference as a way to expand their volume of business. They argue that this would lead to efficient spectrum use in many circumstances (*i.e.*, no tragedy of the commons). Even more controversially, commons advocates maintain that equipment manufacturers would be as powerful an engine for innovation in a commons regime as licensees and their suppliers are in a market regime.

Criticism of the Unlicensed Commons Approach

Support for the unlicensed approach to spectrum governance appears to be concentrated in the computer science community and the information technology (IT) industry; the IT industry benefits directly from the sale of computer networking equipment and indirectly from having such equipment more broadly available as a complement to its other products. Much of the intellectual leadership has come from some prominent legal scholars who see in unlicensed access a fundamental reform of radio law.[6] Their detailed treatises have attracted a larger following of individuals who favor unlicensed spectrum as an "ideal of freedom." [7]

This movement has generated strong criticism as well—primarily (but not exclusively) from economists. Critics maintain that the commons approach lacks the essential advantage that property rights provide—namely, economic incentives that will ensure efficient use of the spectrum and promote investment in innovation. For example, the Progress and Freedom Foundation (PFF) recently released a report on spectrum policy by a prominent panel of experts that includes three former FCC chief economists and the agency's former chief technologist.[8] Although the panel acknowledges that "there is considerable disagreement (even within this

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6 See, for example, Larry Lessig, *The Future of Ideas: The Fate of the Commons in a Connected World* (Random House, 2001); and Yochai Benkler, "Overcoming Agoraphobia: Building the Commons of the Digitally Networked Environment," *Harvard Journal of Law & Technology* 11: 287 (1997). For a recent response to the Benkler and Lessig, see, "Spread Spectrum is Good, But it Does Not Obsolete N.B.C. v. U.S.!," by Charles Jackson, Raymond Pickholtz, and Dale Hatfield, *Federal Communications Bar Journal*, Vol. 58, No. 2 (April 2006).

7 See http://www.volweb.cz/horvitz/os-info/whatis-OS.html for example.

8 "Digital Age Communications Act: Report from the Working Group on New Spectrum Policy," Progress and Freedom Foundation (March 2006). The sections of the report quoted below appear on pp. 3-7.

working group) over what should replace [command-and-control regulation]," the group concludes that the commons approach cannot be the primary direction of spectrum reform.

The Working Group highlights two inherent problems with the commons approach. First, because it lacks property rights, "the large investments needed to use the available spectrum efficiently and create new wireless services are likely to be delayed and/or dampened, with adverse consequences for the U.S. economy."[9] The report acknowledges that the model might have some initial appeal for small, innovative providers, but concludes that it is "insufficiently specific about how efficient priorities will be established and … based on strong conjectures about future radio technology." Second, the group faults the absence of "market-determined prices as the mediating mechanism in spectrum usage decisions." The report concludes that, in this respect, the commons model retains a core (negative) attribute of command-and-control.

The Working Group also expresses concern that the commons model is more susceptible than a market approach to political pressures favoring inefficient outcomes—another weakness of the legacy regime:

> For example, even if technological developments lead to a situation in which moving millions of Wi-Fi users is efficient, it is difficult to see how there could be the political will to do so. Experience indicates that markets are much more likely to adjust continually to underlying conditions of tastes and technology than are political decisions.

Notably, the panel rejects the claim that *new technologies* such as Wi-Fi and cognitive radio either favor a commons regime or will not succeed in a property rights environment. In fact, higher-power versions of those technologies, such as WiMax, will tend to favor a licensed regime because channel contention will be greater as will the need for infrastructure investment, the report concludes. The group argues that even the lower power uses that are currently extolled as successful examples of unlicensed operations could be handled by a property rights regime: for example, an investor could license the use of a specific frequency to an equipment manufacturer, who would sell users the product (say, a Wi-Fi router) and the spectrum rights jointly. The panel notes that this approach would be more efficient than an unlicensed approach, in which the use of the product is under-priced, because users do not have to pay the opportunity cost of the spectrum.

The Working Group rejects on similar grounds the claim that the potentially large *transaction costs* associated with use of the new technologies provide a justification for the commons approach. The report asserts that "the market often finds clever ways of economizing on transactions costs when there are benefits from doing so," such as having manufacturers pay royalties to spectrum owners.

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9 As the report explains, "We see the benefits of secure priority rights already in the operation of the PCS bands where providers with those rights have made, and continue to make, very large investments. Because there is no mechanism for securing top priority in the commons model, that model provides no comparable incentives for services requiring substantial investment."

The Working Group acknowledges that there is an economic argument for an unlicensed commons. Specifically, a commons is justified in those cases where the efficient price for spectrum use is zero—that is, where the use imposes no incremental congestion costs (and no opportunity cost)—*e.g.*, a garage door opener operating in a low-power band. But the report cautions that the number of such cases is likely to be small.

"Round 3"

Advocates of the property rights and commons approaches have engaged in a rich debate over the last decade, and that process, together with developments in industry and government, has produced a degree of convergence. Many commons advocates have retreated from the claim that new technology will bring an end to spectrum scarcity and abandoned calls for broad swaths of dedicated unlicensed spectrum. For their part, most property rights advocates have acknowledged the benefits from some of the FCC's unlicensed allocations and recognized the inevitability of a mixed regime.

That said, as the PFF report illustrates, leading property rights advocates have held to their position that there is only a limited justification for unlicensed commons. In part, that reflects their belief that a property rights regime, unlike a commons regime, would allow those subject to it to have their cake and eat it too—that is, that licensed spectrum can accommodate not just exclusive use but also the kinds of shared use now associated with unlicensed bands.[10]

Similarly, the tenor of the debate has gone from philosophical to results-oriented, as the conflict of ideas over spectrum management has entered what Professor Gerald Faulhaber calls "Round 3."[11] In particular, both sides have recognized the importance of key practical issues, including transaction costs, dispute resolution, and the need to provide for future flexibility.

In that spirit of pragmatism, there has been a growing recognition that the choice of governance regime for individual spectrum bands should reflect a clear understanding of the tradeoffs between alternative approaches—what economists call a marginal allocation problem. Several

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[10] The argument that a licensed band can accommodate unlicensed uses is correct in theory: any transmitter that can be operated in an unlicensed regime can be operated in a licensed regime. Nevertheless, there may be impediments to the implementation of a "private commons." A key issue is enforcement: If a microwave oven manufacturer were to buy the rights to a band for its customers to use on a shared basis, what would prevent customers of a competing manufacturer from trespassing? Although the first manufacturer could bring legal action, it would have to identify the trespassers—no easy feat, especially if the trespassing systems are low-power, located indoors and used infrequently. In addition, there are problems with any theory of trespass (*e.g.*, one could argue that the alleged trespassers caused no direct harm because they would not have interfered with or precluded use of the band by any of the manufacturer's customers; if so, the efficient levy of damages would be zero). Enforcement issues aside, with so much spectrum having been made available for unlicensed use, manufacturers of devices suited to such use may have little incentive to buy or lease their own spectrum. For a discussion of the enforcement problem, see Jon M. Peha, "Spectrum Management Policy Options," *IEEE Communications Surveys* (Fourth Quarter 1998), p. 3.

[11] Gerald R. Faulhaber, "The Question of Spectrum: Technology, Management, and Regime Change," *Journal on Telecommunications and High Technology Law*, Volume 4, Issue 1 (2005).

proposals—including Democratic presidential nominee John Kerry's proposed set-aside of 30 MHz of the 700 MHz band for dedicated unlicensed use, and the FCC's current proceeding on the 3650 MHz band—have generated relatively thoughtful, balanced discussions of the benefits and opportunity costs of markets versus spectrum commons. By contrast, as we will discuss below, the white space debate has been wholly one-sided.

B. TV White Space

The history of efforts to exploit vacant TV channels for non-broadcast use is long and complex. Much of the pre-1996 history involves land mobile radio; we need not recite it here, except to make two points. First, licensed allocation of TV white space is longstanding practice, not just theory. For example, in 1971, the FCC authorized the use of 12 MHz of unused TV spectrum for land mobile services in each of several major metropolitan areas. Second, opposition by the incumbent broadcasters has impeded more such reallocation. Most prominently, in the mid-1980s, the National Association of Broadcasters blocked a proposed reallocation of vacant TV frequencies to land mobile on the rationale that its members would need the spectrum in order to convert to high definition TV technology when it became available.[12]

Pressler Plan

Ten years later, a proposal by Senate Commerce Committee Chairman Larry Pressler to license *all* unoccupied spectrum in the TV band encountered similar resistance. The proposal was part of an ambitious plan to liberalize spectrum, generally, and to facilitate the use of (some) broadcast spectrum for higher value wireless applications, specifically. The Pressler plan directed the FCC to allocate all spectrum in the TV band to overlay licenses that would be assigned via auction. Winning bidders would have the right to use any spectrum not encumbered by existing analog TV stations or future digital TV stations (*i.e.*, the white space). In addition, the plan exempted from auction the licenses that, under the just-passed 1996 Telecommunications Act, were to be given to broadcasters for the provision of digital TV during the analog-to-digital transition (the Pressler plan did require licensees to pay a deposit that would be refunded when they turned in their analog license), and allowed broadcasters to provide non-TV services in addition to, or in place of, broadcasting.[13]

Sen. Pressler withdrew his draft plan in a matter of days in the face of intense opposition—primarily from broadcasters, who objected to the licensing of unoccupied TV spectrum. The plan drew criticism from the other side as well, echoing earlier objections by commentators and

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[12] Thomas W. Hazlett and Matthew L. Spitzer, "Digital Television and the Quid Pro Quo," *Business and Politics,* Vol. 2: No. 2 (2000), p. 124.

[13] Thomas W. Hazlett, "The Wireless Craze, the Unlimited Bandwidth Myth, The Spectrum Auction Faux Pas, and the Punchline to Ronald Coase's 'Big Joke': An Essay on Airwave Allocation Policy," *Harvard Journal of Law & Technology* 14: 337-469 (2001), p. 442.

Members of Congress to the proposed "giveaway" of digital TV licenses as well as to proposals that would allow digital TV licensees to provide non-broadcast services.[14]

Despite the overwhelming political objections it generated, the Pressler plan reflected the view of many experts that a shift of broadcast spectrum to non-broadcast services could produce large efficiency gains.[15] The shorthand expression for this widely held view is "Negroponte's Switch," referring to the observation by MIT computer scientist Nicholas Negroponte that people increasingly get their TV over wires and their telephone service over the air—just the reverse of the traditional pattern.

The creation of overlay rights to the TV spectrum (white space) was also seen by many as a practical way to allow for the productive use of that valuable spectrum in the short term—one that, in combination with a grant of technical flexibility to broadcasters, would facilitate the Negroponte switch over the longer term. The regions in which television signals are protected from interference are roughly circular regions with a radius of about 60 to 100 miles. There are necessarily gaps between these regions—that is, areas defined by TV channel and geographic location in which the spectrum does not contain a TV signal that is protected from interference. Although these gaps are too small to permit operation of a TV station, digital technology makes it possible for them to be used for other purposes without interfering with TV reception.

Recent Debate—The Sound of One Hand Clapping

In recent years, commons advocates have pursued Sen. Pressler's goal of allowing access to the TV white space, albeit on an unlicensed basis—a significant difference. The broad coalition supporting these proposals includes self-styled consumer and public interest groups as well as information technology firms such as Intel and Microsoft.

Unlicensed advocates maintain that the white space could easily be detected and utilized by (unlicensed) cognitive radios for a variety of valuable new wireless applications, providing substantial consumer benefits. The unlicensed applications they cite include accelerated deployment of wireless broadband service to rural areas; new, cutting-edge consumer applications that take advantage of the superior reliability and range of signals in this spectrum (*e.g.*, home automation and power monitoring, home security with robust low power wireless video feeds, and data and video distribution within the home); and auxiliary services to augment public safety communications on licensed networks (*e.g.*, placement of remote video cameras at a disaster site to relay images to a command center, and use of portable "helmet cams" to provide real-time, point-of-view command/control information).

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14 For a discussion of the "giveaway" controversy prior to and during the debate over the 1996 Act, see Hazlett and Spitzer, *op cit.*, pp. 130-131.

15 Support for that view came from a 1995 FCC estimate that the spectrum covered by the digital TV licenses was worth between $11 billion and $70 billion, based in part on the revenues from the most recent FCC auction of PCS licenses. Unfortunately, the estimate served largely to embolden "giveaway" critics by quantifying the magnitude of the perceived windfall to broadcasters.

The coalition found broad support among Members of the Senate Commerce Committee, which approved legislation last year to facilitate unlicensed access to the TV white space. The FCC's 2004 proceeding adopted a similar goal. Broadcasters have strongly opposed these efforts on the grounds that unlicensed access to the TV band would create harmful interference.

Remarkably, prior to the FCC's October 2006 Further Notice of Proposed Rulemaking, these deliberations excluded virtually any mention much less consideration of a licensed approach. Unlicensed advocates argued for open access to the white space as if it were the only alternative to the status quo. And they devoted their analysis almost exclusively to refuting broadcaster claims that unlicensed devices would harm TV reception.

Similarly, the Senate Commerce Committee, whose chairman had in the past supported spectrum auctions, did not appear to consider the possibility of an auction of licensed rights to the white space. For example, at the Senate Commerce Committee's March 2006 hearing on spectrum reform, several witnesses testified in favor of the Committee's draft legislation to authorize unlicensed use of the white space, and the broadcasters testified against it; as usual, the two sides focused on technical disagreements over interference.[16] Another witness—the economist who co-chaired the Progress and Freedom Foundation's Working Group on spectrum policy—presented the group's recently released recommendations on the economic benefits of spectrum "propertization" and the economic costs of a commons approach (he did not mention the white-space issue, specifically). Not a single Member acknowledged the direct contradiction between the Working Group's recommendations and the Committee's white-space legislation.

As the hearing illustrated, the white-space debate has marked a departure from the constructive trend described earlier, in which both sides treat the choice of regime in an individual band as a marginal allocation problem. Instead of a rich discussion of the tradeoffs between a market-based approach and an unlicensed commons, the white-space debate has been an argument regarding the pros and cons of permitting unlicensed uses. Analytically, it has amounted to the sound of one hand clapping.

The argument over unlicensed access to the white space has been a limited one, at that. Dominated by engineers, it has focused almost exclusively on technical questions about interference. This clash of technical experts has diverted attention from fundamental economic questions: Will unlicensed access to the TV white space work as a commercial matter? Will it really produce the policy benefits that its advocates claim? Will it help or hinder the long term transition of the TV band to higher value applications?

Ultimately, what matters is whether the benefits from an unlicensed approach to the TV white space will exceed those from a licensed approach—one that more nearly approximates a market. That is an economic policy question, not a technical question, although technical considerations

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[16] Intel's testimony included only one page on consumer benefits and more than three pages on why interference would not harm broadcasters. Testimony of Kevin Kahn, Intel Corp., before the Senate Committee on Commerce, Science and Transportation, Hearing on "Wireless Issues/Spectrum Reform" (March 14, 2006).

are critical to be sure. To answer the economic question, policymakers must look at, among other things, the practical issues, including transaction costs, dispute resolution and future flexibility. In short, the process should generate the sound of two hands clapping.

III. HOW MUCH WHITE SPACE WILL THERE BE?

In theory, the choice of governance regime should not turn on how much white space will be available following the DTV transition: either approach (licensed or unlicensed) is feasible regardless of the amount of white space. In practice, however, both the amount and geographic distribution of white space could make a difference in the relative appeal of one approach or the other. For example, if many urban areas have less than 6 MHz of white space, that could limit the appeal of a licensed regime by precluding nationwide service. Conversely, the availability of a large amount of white space would increase the appeal of a licensed regime.

In their narrow debate over the merits of unlicensed access, both the unlicensed advocates and the broadcasters have generated white space estimates, and their results are far apart. On the unlicensed side, most prominently, Free Press and New America Foundation (FP/NAF) looked at 22 TV markets and found that all of them will have a significant number of vacant channels after the DTV transition, ranging from 15 (Trenton, NJ) to 41 (Fargo, ND).[17] On the other side, the Association of Maximum Service Television (MSTV) concluded that there would be almost no locations in the Northeast (among other places) where an unlicensed device could operate without causing interference to DTV reception.[18]

However, both studies have limitations, particularly for regulators trying to choose between the licensed and unlicensed options. The MSTV study is based on a massive and sophisticated computation that incorporates detailed measures of topography, but it defines white space using an interference protection rule that would be excessive if the white space were licensed. Stated differently, MSTV's results underestimate the amount of white space that would be available in a licensed regime. The FP/NAF study is more fundamentally flawed. It treats each channel in a given market as either occupied (no white space) or vacant (100 percent white space), depending on whether a station operates on that channel. That binary approach both underestimates and overestimates the actual amount of white space.[19] It also ignores population, which is key: 6 MHz of white space should count for more if it is located in a densely populated region than in a sparsely populated one.

Because of the limitations of the existing studies, we developed our own estimate of how much white space there will be following the DTV transition. We used a more sophisticated, disaggregated approach than that of FP/NAF to calculate white space, so as to avoid the flaws in

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[17] Free Press and New America Foundation, "Measuring TV 'White Space' Available for Unlicensed Wireless Broadband," January 5, 2006.

[18] See Attachment A of "Joint Reply Comments of the Association for Maximum Service Television, Inc. and the National Association of Broadcasters, ET Docket 04-186, January 31, 2005.

[19] The FP/NAF study implicitly assumes that a broadcast station occupies an entire channel—i.e., that it encumbers the entire metropolitan market ("market" is defined as the relevant Nielsen designated marketing area, or DMA). In fact, even high-power stations may not cover an entire DMA, and low-power channels usually cover far less. In that respect, the FP/NAF study undercounts white space. It overcounts white space by only partially accounting for out-of-market signals (signals from one market that spill over into another). (The FP/NAF study also ignores the possible need to protect adjacent channels, although it is easy enough to adjust the results taking that into account.)

their study. To address the limitation of the MSTV study, we did those calculations under different scenarios—*i.e.*, using alternative assumptions about the appropriate level of interference protection, as described below.[20]

Our Basic Approach

Briefly summarized, our methodology involved three steps: First, we defined white space as those locations—in frequency and geography—where broadcast signals do not need protection. We used the B contour—the FCC-designated coverage area—as the measure of what needs protection, and we calculated that coverage contour for each DTV antenna, based on its channel, power and height. We included more than 10,000 antennas, including more than 2,700 DTV stations and nearly 8,000 class A TV stations, TV translators and land mobile systems.

Second, we calculated the population within each B coverage contour. To do that, we summed the population in every census tract block group within an individual contour. A census tract block group is the smallest geographic unit for which the U.S. Census publishes population data; individual census tract block groups, on average, are 16 square miles in area and include about 1,300 people. There are more than 200,000 census tract block groups in the United States.

Third, for each of the 49 channels (2-36 and 38-51), we calculated the total U.S. population that is covered by antennas operating on that channel anywhere in the country. Through simple subtraction, we then calculated the U.S. population that is not covered by that channel (total U.S. population minus the number of people covered by a particular channel equals the number of people not covered by that channel). That non-covered population represents the white space—that is, if 50 percent of the total U.S. population is not covered by channel 2, then, on average, we can regard half of channel 2 (3 MHz) as white space on a national basis.

Specific Measures

Using these results, we aggregated the amount of white space across all 49 channels and subsets thereof. We also used our basic approach to calculate results at a regional level. Specifically, we used the 52 Major Trading Areas, or MTAs, each of which contains a major metropolitan area and surrounding rural areas. For each MTA, we calculated the *average* amount of white space (averaged across census block groups). In addition, and to provide a more meaningful measure of capacity, we calculated the *minimum* amount of white space—measured in 6 MHz increments—representing the smallest amount of white space available to any census tract block group within the MTA (an MTA contains thousands of census tract block groups).[21]

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[20] MSTV calculated interference effects using data on actual terrain along the propagation path. As a shortcut, we used average height above terrain as listed in the FCC records. In that key respect, our analysis is less sophisticated and rigorous than that of MSTV.

[21] For example, under one scenario (Scenario X), New York has 140 MHz of white space, on average, and a minimum of 78 MHz, or 13 channels. Note that this does not mean that the same 13 channels are vacant throughout New York. Rather, it means that 13 channels are vacant at any point in the MTA; the identity of those channels may (and likely will) vary from point to point.

Using national data, we calculated a cumulative distribution chart of white space. Such a chart shows the minimum amount of white space (measured in 6 MHz increments) that is available to any given fraction of the population. In addition to the "basic" chart, which includes all 49 channels (2-51), we calculated cumulative distribution charts for smaller subsets of channels.[22] The cumulative distribution chart is perhaps the single most important measure of white space, because it speaks to the commercial feasibility of nationwide service: a licensee would probably need to have at least 6 MHz of white space in enough geographic locations to reach most (say, 90 percent) of the population in order to offer such service.

We also calculated certain results at the level of the basic trading area (BTA), which are smaller than MTAs. (There are a total of 493 BTAs.) Specifically, for each BTA, we identified the number of channels that are entirely vacant (*i.e.*, 100 percent white space at every point in the BTA). This is a complement to our measures, described above, of the minimum amount of white space available across census tract block groups. It is relevant because the availability of one or more BTA-wide vacant channels could reduce the amount of engineering needed to provide service in the white space. (Although we discuss the results below, we do not include the BTA-level charts in the Appendix.)

Scenarios

We ran these calculations for four different scenarios:

- Scenario X: All DTV and Class A stations and land systems; no adjacent channel protection
- Scenario Y: Same as Scenario X but with adjacent channel protection[23]
- Scenario Z: Same as Scenario Y plus TV translators
- Scenario UL-1: Same as Scenario Y but with a geographic buffer in the co-channel and the adjacent channel[24]
- Scenario UL-2: Same as Scenario UL-1 but with channels 2-4 and 14-20 excluded

Scenarios X, Y and Z correspond to interference rules that we view as appropriate to a licensed regime, where it would be possible to engineer white-space operations in close to the contour using directional antennas and low-power transmitters. (We view Scenarios Y and Z as the most

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[22] Throughout our analysis, we excluded channel 37, which is set aside for use by radio astronomers and is not considered part of the TV band.

[23] For those scenarios (Y, Z and UL-1 and UL-2) that provide adjacent channel protection, we followed the basic approach described above, but we treated each DTV facility as if it operated at three channels—its own channel and the channels directly below and above.

[24] For Scenarios UL-1 and UL-2, we followed the basic approach described above, but instead of measuring white space as everything outside the B contour, as we did for Scenarios X, Y and Z, we allowed for a significant buffer: the co-channel buffer is 46, 30 and 17 miles for low VHF, high VHF, and UHF, respectively; the adjacent channel buffer is 5 miles.

likely, because of the high probability that the FCC would require adjacent channel protection even in a licensed regime.) By contrast, Scenarios UL-1 and UL-2, with the additional geographic buffer, correspond to interference rules that would be appropriate to—and which the FCC would be likely to impose on—mobile or nomadic devices in an unlicensed regime. Scenario UL-2, which excludes channels 2-4 and 14-20, closely mirrors the FCC's latest proposals for an unlicensed regime.[25]

Results

Our methodology and results are presented in detail in Appendix A. Table 1 provides a summary of our results. Four points are key:

- Scenario X, which does not provide for adjacent channel protection, has significantly more white space than Scenarios Y and Z, which do. Adjacent channel protection reduces the amount of white space available by about half, generally speaking.
- However, even under Scenarios Y and Z, there is a critical mass of white space available nearly everywhere. Most significant, 95 percent of the population will have access to at least 24 MHz of white space (all channels included). As noted above, these two scenarios correspond to the level of protection that the FCC is most likely to demand under a licensed regime.
- The additional buffer protection provided in Scenario UL-1 reduces the availability of white space significantly relative to Scenarios Y and Z—by one-quarter to one-half, depending on how it is measured. Because Scenario UL corresponds to the higher level of interference protection that we believe the FCC would demand in an unlicensed regime, that reduction in white space can be thought of as the "loss" associated with using an unlicensed as opposed to a licensed approach. However, because Scenario UL-1 includes all 49 channels, it probably understates that "loss."
- Scenario UL-2 corresponds most closely to the level of interference protection that we believe the FCC would be likely to demand in an unlicensed regime. This scenario shows a noticeable reduction in white space even compared to Scenario UL-1, and only about half as much white space as Scenarios Y and Z.

Figures 1-4 show selected results for Scenarios Z and UL-2, which are the scenarios that we consider to be most representative of the kind of interference rules that the FCC would adopt in a licensed and unlicensed regime, respectively.

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[25] The FCC has proposed to exclude mobile devices from channels 14-20, and it has requested comments on whether to exclude fixed devices. Channels 2-4 would be off limits for fixed and mobile devices under the FCC's proposal.

Specifically, for Scenario Z, Figure 1 shows the minimum amount of white space available by MTA. Only one MTA (San Francisco/Oakland/San Jose) has less than 6 MHz of white space. Every other MTA has a minimum of 12 MHz of white space available, and most MTAs have significantly more—*e.g.*, New York and Chicago have 18 MHz, Detroit and Cleveland have 24 MHz, Boston has 42 MHz, and Phoenix has 84 MHz. Figure 2 shows the cumulative distribution of white space for all 49 channels under Scenario Z. For example, 99 percent of the U.S. population has access to at least 18 MHz of white space; 97 percent has access to at least 24 MHz; and 91 percent has access to at least 30 MHz. Our BTA-level analysis, which is not shown graphically, reveals that under Scenario Z, 90.5 percent of all BTAs have at least two fully vacant channels. These BTAs account for 62 percent of the U.S. population.

The parallel results for Scenario UL-2 are strikingly different. Figure 3 shows that fully seven MTAs have less than 6 MHz of white space and another six MTAs have only 6 MHz. Similarly, Figure 4 shows that only 92 percent of the population has access to 6 MHz of white space. The BTA-level analysis (not shown graphically) reveals that only 73.2 percent of BTAs have at least two fully vacant channels; those BTAs account for only 41 percent of the population.

Conclusion

Our results should be viewed as approximate rather than exact: we believe that the nationwide results (*e.g.*, the cumulative distribution charts) are reasonably accurate, but our results for any individual MTA will exhibit greater variability around the actual figures. Two key factors limit our ability to estimate the amount and location of white space with greater accuracy. First, our approach to calculating the necessary interference protection is more approximate than the one used by MSTV, which required months of continuous computer processing. Second, the list of post-transition licensees (both broadcast stations and translators) is still somewhat in flux. (Note that we included even stations that did not appear to have submitted a DTV application; for purposes of our analysis, we assumed that they would ultimately operate a DTV station at their analog channel.) Uncertainty about the FCC's interference rules is another limiting factor, although we have addressed that issue by estimating white space under alternative interference-rule scenarios.

Despite these caveats, one result comes through clearly (and it accounts for much of the difference between the results obtained by MSTV versus FP/NAF): the amount of white space differs dramatically depending on the (assumed) interference rules. Moreover, the interference rules that are most appropriate to an unlicensed spectrum model result in substantially less white space than even the most conservative rules that in our view are appropriate to a licensed model. Stated simply, there is far more white space in a licensed environment than in an unlicensed environment, because the FCC interference rules do not need to be as protective. (In Section V, we will discuss another fundamental reason that licensing would result in more white space—namely, the parties would have the incentive and the ability to negotiate variances from the FCC interference standards.)

Table 1
Measures of White Space under Alternative Interference-Protection Scenarios

	Included Facilities	Co-Channel Protection	Adjacent-Channel Protection	*Total MHz-Pops in White Space (Millions)* 2-51	5-51	14-51	*Percent of MHz-Pops in White Space* 2-51	5-51	14-51	*White Space Bandwidth Covering 100% of Total Population* 2-51	5-51	14-51	*White Space Bandwidth Covering 95%+ of Total Population* 2-51	5-51	14-51	*Average White Space Bandwidth Available Nationwide* 2-51	5-51	14-51
Scenario X	All US, Canadian, and Mexican regular and Class A stations and land systems in the UHF TV spectrum.	FCC Radius	None	53,678	49,232	37,829	64%	63%	60%	78	60	36	108	90	60	188	173	133
Scenario Y	All US, Canadian, and Mexican regular and Class A stations and land systems in the UHF TV spectrum.	FCC Radius	FCC Radius	28,266	24,532	17,379	34%	31%	27%	0	0	0	24	12	6	99	86	61
Scenario Z	All US, Canadian, and Mexican regular and Class A stations, land systems in the UHF TV spectrum, and all TV translators.	FCC Radius	FCC Radius	27,156	23,523	16,547	32%	30%	26%	0	0	0	24	12	6	95	82	58
Scenario UL-1	All US, Canadian, and Mexican regular and Class A stations and land systems in the UHF TV spectrum.	FCC Radius plus 46, 30, and 17 miles for low VHF, high VHF, and UHF	FCC Radius plus 5 miles	21,028	18,093	12,752	25%	23%	20%	0	0	0	12	6	0	74	63	45
Scenario UL-2	All US, Canadian, and Mexican regular and Class A stations and land systems in the UHF TV spectrum. Channels 2-4 and 14-20 excluded.	FCC Radius plus 46, 30, and 17 miles for low VHF, high VHF, and UHF	FCC Radius plus 5 miles	15,160	15,160	9,820	18%	19%	16%	0	0	0	0	0	0	53	53	34

Figure 1

Minimum Bandwidth of White Space by MTA -- Scenario Z

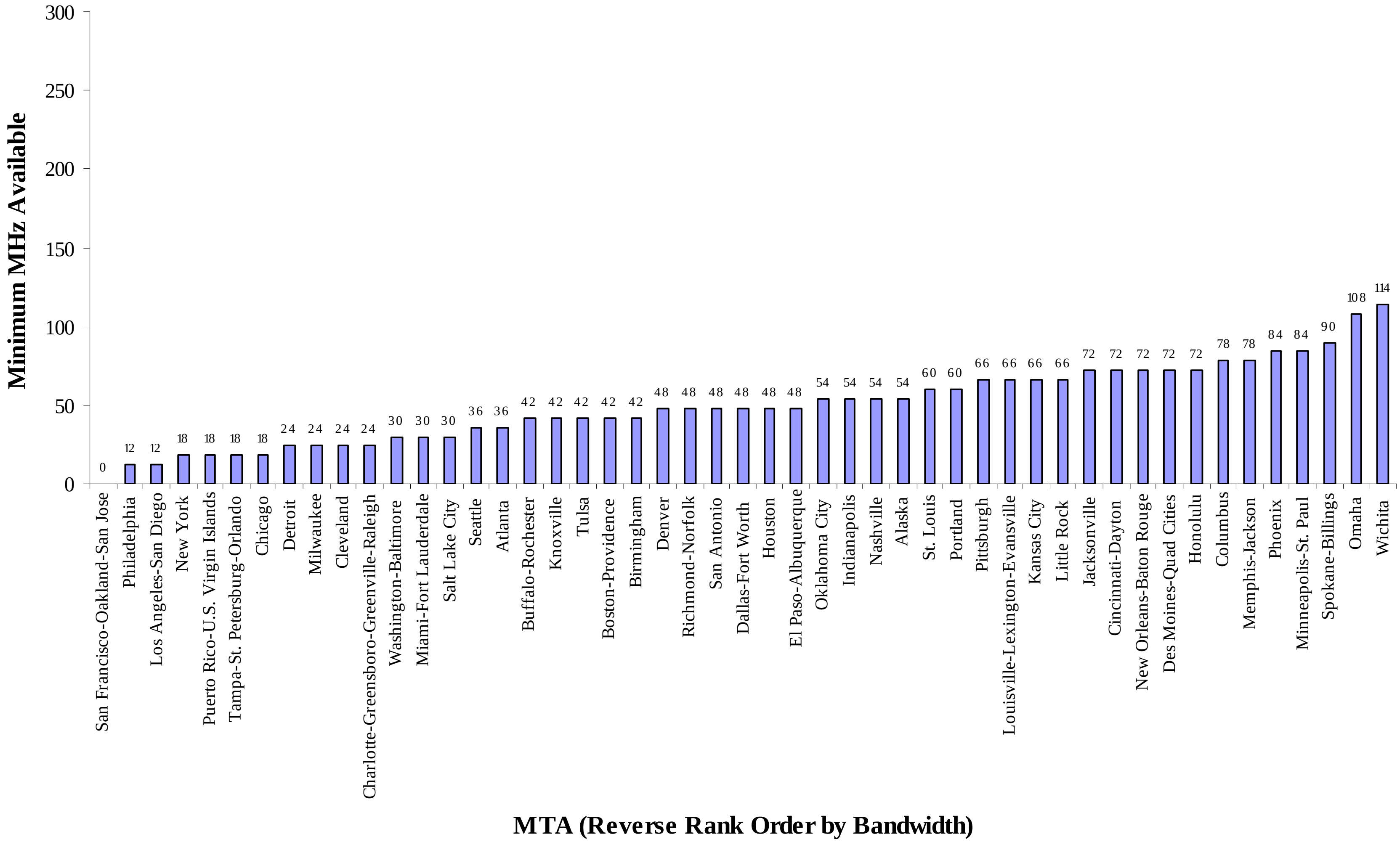


Figure 2

Percent of Population with a Given Amount of White Space -- Scenario Z

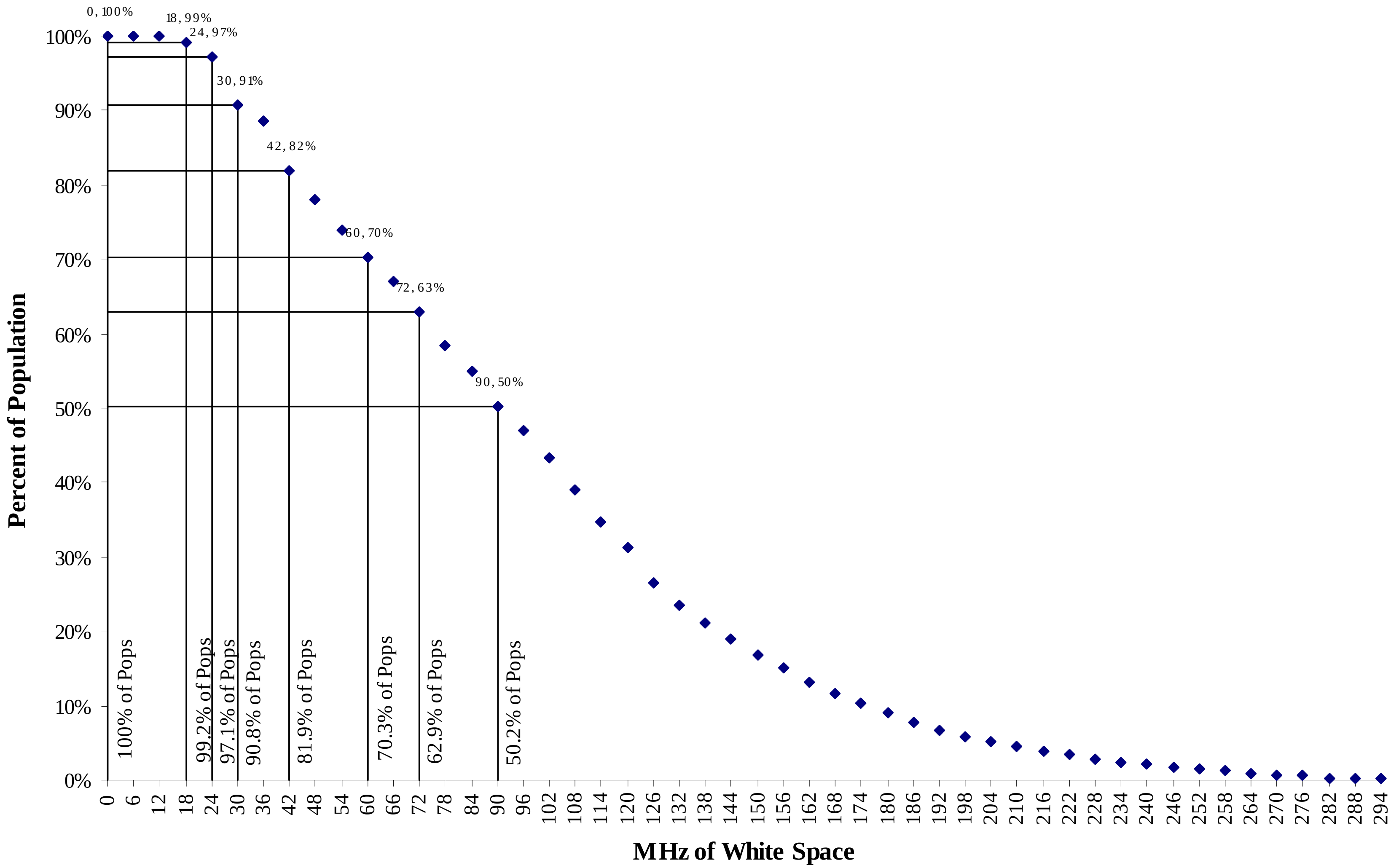


Figure 3

Minimum Bandwidth of White Space by MTA -- Scenario UL-2

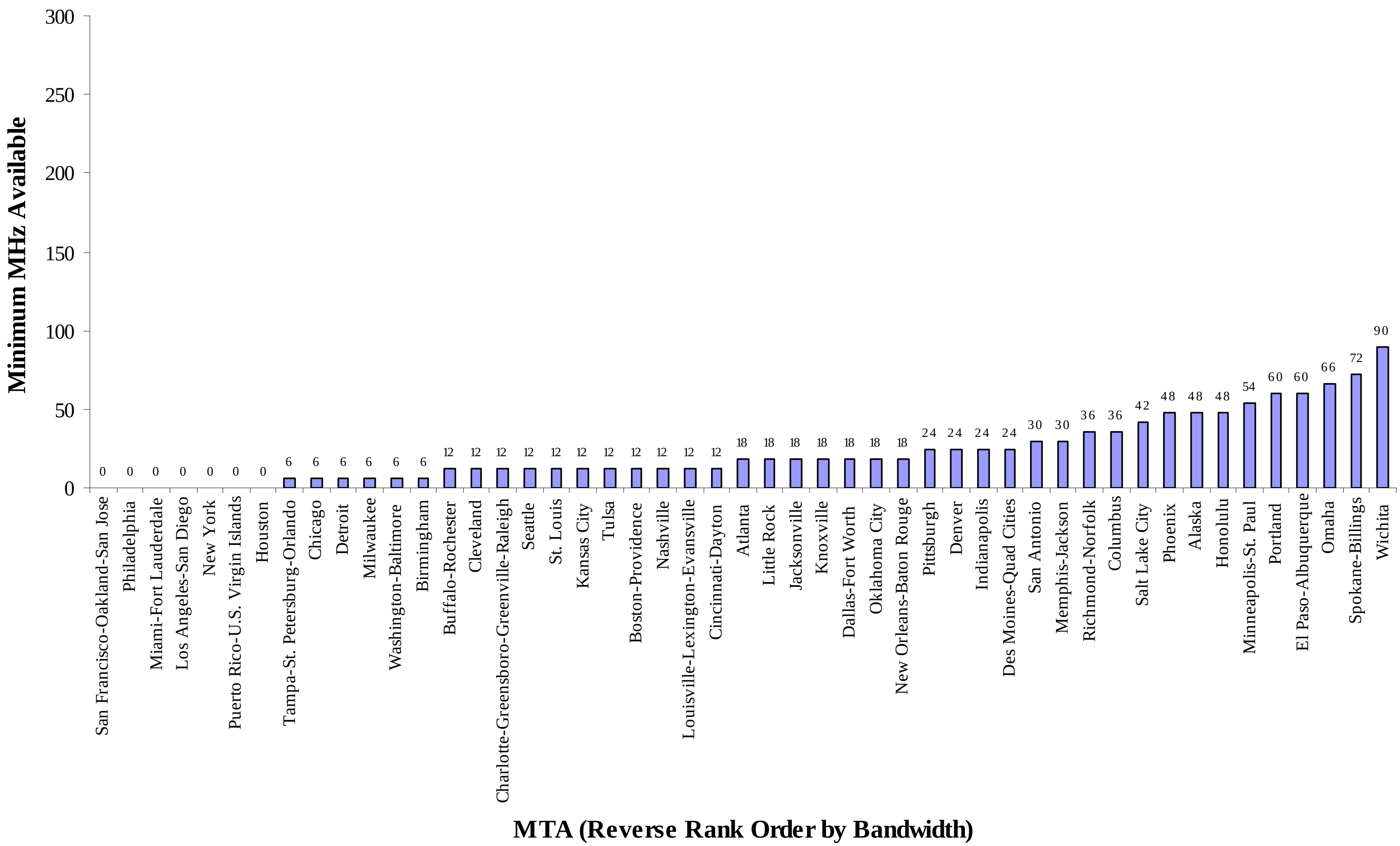
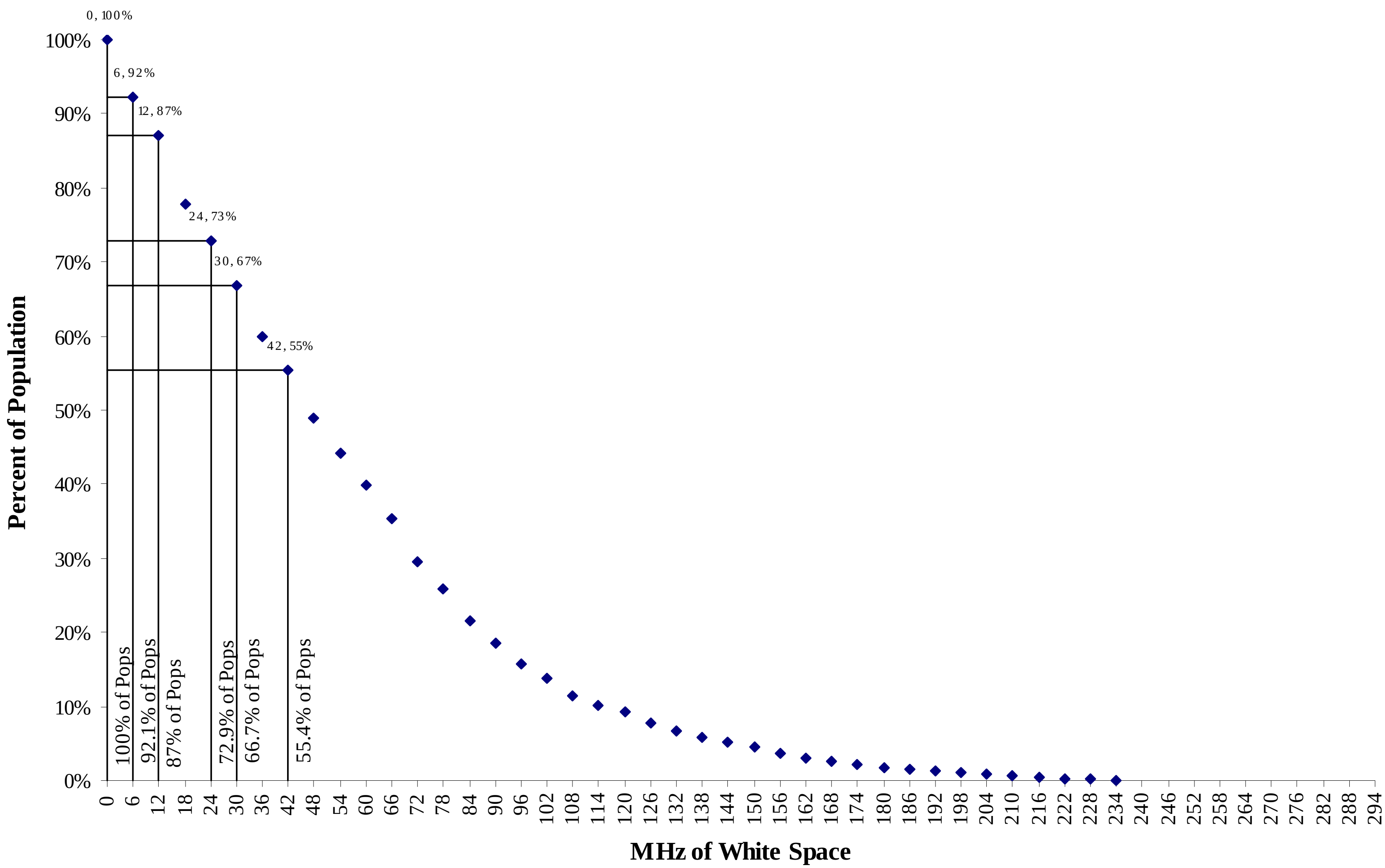


Figure 4

Percent of Population with a Given Amount of White Space -- Scenario UL-2



IV. UNLICENSED USE OF THE TV WHITE SPACE

Overview: Unlicensed advocates make what may appear, on the surface, to be a compelling case for shared access to the TV white space. However, their key arguments underscore the value of *access* to vacant TV spectrum, not necessarily unlicensed access. Other arguments fail to address potential problems and limitations associated with unlicensed access, generally, or access to *the TV band*, specifically. We highlight three key problems with an unlicensed approach to the white space. First, technical and economic factors will likely discourage the necessary investment in unlicensed systems either for short-range data transfer or for long-range applications. Second, these impediments to investment, together with the large amount of unlicensed spectrum that already exists, mean that the incremental benefits from an additional allocation will be limited, and the opportunity cost will be high. Third, over the long run, an unlicensed underlay will create a constituency of squatters and their suppliers, which will impede the evolution of the TV band to higher value uses.

A. The Flawed Case for Unlicensed Access to the White Space

Opportunity Cost of Status Quo: The basic economic argument that proponents make for unlicensed use of TV white space boils down to the opportunity cost of the status quo. When asked why his company advocated open access to the white space, Intel's Mike Chartier summed it up this way: vacant TV spectrum represents a valuable resource that is currently going to waste.[26] The New America Foundation makes the same case in more detail; their reports cite the exceptional qualities of the TV band and note that digital technology has turned TV white space into usable spectrum much as air conditioning turned the Southwest into prime real estate.[27] The bottom line: having this valuable spectrum sit idle means a benefit foregone.

Even more costly than letting white space sit idle, according to unlicensed advocates, is the FCC's practice of allowing broadcasters to lay claim to it—*e.g.*, for the use of wireless microphones. Unlicensed advocates criticize this transfer on the grounds that low frequency spectrum is better suited for mobile broadband than broadcasting. They argue that broadcasters' campaign to win free rights to unused spectrum, together with their opposition to unlicensed use of white space, will delay that inevitable change.[28]

The basic logic behind these arguments is compelling: TV white space *is* valuable, and allowing it to sit idle *does* impose an opportunity cost. But it does not follow that the FCC should, in effect, give the white space away by opening it up to one and all. It is at least as plausible (more

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[26] Mike Chartier, Director of Spectrum Policy, Technology Policy and Standards, Intel Corp., Comments at "MSTV@50: Shaping the Future of Television," October 3, 2006.

[27] J. H. Snider, "Reclaiming the Vast Wasteland: The Economic Case for Re-Allocating the Unused Spectrum (White Space) Between TV Channels 2 and 51 to Unlicensed Service," New America Foundation, Working Paper # 13 (February 2006).

[28] According to the New America Foundation, these FCC actions amount to a $6 billion transfer of spectrum rights. Snider, *op. cit.*, p. 2.

so, we maintain) to suggest that the FCC should sell or otherwise assign the spectrum rights to the white space on an exclusive basis—an option that unlicensed access would preclude.

In addition to arguing that TV white space is a valuable resource that is going to waste, unlicensed advocates maintain that its propagation characteristics would allow unlicensed devices to operate more cheaply and effectively than they can in the higher frequency bands where most unlicensed activity now occurs (2.4 and 5 GHz). In particular, they emphasize the potential benefits to underserved rural areas. Here again, however, the argument applies not just to an unlicensed regime: devices designed for licensed spectrum will also operate more cheaply and effectively at a low frequency, all else equal, making it less expensive to serve rural areas.

In sum, the major argument for unlicensed access to the white space—the opportunity cost of the status quo—should be seen as an argument for *access* to the white space. Moreover, because an unlicensed regime would preclude licensed access, it would impose its own opportunity cost.

Transaction Costs: The other (often implicit) economic rationale for unlicensed white space is transaction costs. Pierre de Vries, one of the few proponents of unlicensed spectrum to address this issue directly, maintains that the TV band is better suited to unlicensed use because it is a "junk band"—much like the 2.4 GHz band, which was considered "garbage."[29] What makes the TV band "junk" is, above all, its "Swiss cheese" character: broadcasters (the holes in the cheese) occupy a different pattern of channels in each of the 210 TV markets. According to de Vries, this non-regular pattern of broadcast usage, combined with other conditions that he believes will hold—limited quantities of white space in major urban areas, stringent interference rules to protect broadcasters, and multiple white-space licensees—would make it prohibitively complex and costly to have a market in spectrum rights. By contrast, unlicensed access would avoid the need for costly negotiations and coordination among parties. It would also eliminate the need for spectrum auctions or subleases—a particular advantage in rural areas, where transaction costs could swamp the benefits, in de Vries's view.

However, insofar as an unlicensed approach would minimize transaction costs, it would do so by having users forego the more extensive and efficient uses of the white space that frequency coordination and interference negotiation could achieve under a market approach. This is a fundamental source of inefficiency under the FCC's legacy command-and-control regime, and an unlicensed regime would perpetuate the problem. We will discuss this issue in more detail in Section V. We will also explain there why, contrary to the claims of unlicensed advocates, those coordination activities need not be prohibitively complex or costly.

The claim that the white space is better suited for unlicensed activity because it is in a "junk band" is problematic in another respect. That characterization of the TV band is not necessarily

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[29] Pierre de Vries, "Populating the Vacant Channels: The Case for Allocating Unused Spectrum in the Digital TV Bands to Unlicensed Use for Broadband and Wireless Innovation," New America Foundation, Working Paper # 14, August 2006. See also de Vries's "Talking Points for a Debate with Tom Hazlett on TV Band White Space Use," George Mason University School of Law, November 14, 2006. [http://gmu.edu/departments/law/////nctl/iep/deVries.11.14.06.htmURL link]

wrong. But unlicensed advocates miss the irony: the white space is "junky" in good part because broadcasters have no incentive or ability to sell or lease unneeded bandwidth. Stated differently, the inefficient usage of the TV band is a direct reflection of the fact that the spectrum is regulated by a command-and-control regime that offers little incentive for efficiency and in fact rewards hoarding of spectrum. An unlicensed approach to the white space would perpetuate that problem by precluding private negotiations in favor of rule-based interference management.

Transaction costs are also at the heart of the case for unlicensed access to the white space made by J. H. Snider of the New America Foundation. Snider argues that fundamental economic forces are driving the world toward greater reliance on terrestrial low-power wireless communications. One such force is that high-power wireless service has close, wired substitutes whereas low-power wireless service does not. A second driver of low-power networks is the skyrocketing demand for spectrum: large cell sites make less and less economic sense, in his view, because they can be subdivided to create more capacity. Asserting that unlicensed spectrum works best for these low-power wireless networks, Snider calls for an (unlicensed) underlay that would cover the entire radio spectrum, including the TV band.[30]

However, Snider's unquestioned assumption—that low-power wireless networks are best supported by unlicensed spectrum—is problematic. He defines "low-power networks" narrowly—essentially as networks made up of LAN devices. In fact, modern wireless handsets operate at powers that are every bit as low (maximum powers of about 1 watt and average powers of about 10 milliwatts), and these handsets use licensed spectrum.

Snider's call for a spectrum-wide underlay raises major issues that others will no doubt address in the broader spectrum governance debate. However, a specific objection to his proposal and others like it relates to the white-space debate: allocation of the TV band for low-power, short-range wireless networks would be the equivalent of using land in downtown Tokyo to grow rice.

To elaborate, the TV band is useful for mobile and long-range services because it has better propagation characteristics than higher frequencies—a major plus in rural areas in particular. WiFi and other short-range services fail to take advantage of this property of the TV spectrum while potentially disrupting other services that do want to exploit it. Similarly, it is easier to generate significant power in the TV band than at higher frequencies, which is also useful in rural areas. By restricting users to low power limits, an unlicensed approach fails to take advantage of this valuable feature of the TV spectrum.

In short, the TV white space is "overqualified" for the use to which unlicensed advocates want to put it. Even if Snider and other unlicensed advocates are right about the inexorable growth of low-power WiFi networks, it would be a spectral "sin" of omission to use vacant TV channels to satisfy that demand. Ironically, this is just the crime of which unlicensed advocates, quite rightly, accuse the current regime.

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30 Snider, *op.cit.*.

Public Policy Goals: Unlicensed white space is also touted as a cost effective way to meet key policy goals. The most politically salient claim is that it would facilitate broadband access to underserved rural areas. However, insofar as the claim turns on the superior features of the TV band, a licensed system could exploit those same advantages, as we have noted. Unlicensed advocates counter that rural providers can't always get licensed spectrum even if they want it, because of the high transaction costs of sublicensing. However, many underserved areas are not viable markets because of the high cost of providing service. For those markets, lower transaction costs in the form of unlicensed white space will not help.

Ultimately, only a licensed approach offers the certainty necessary for wireless providers to make the large investments in long-range infrastructure that rural broadband requires. Unlicensed advocates have yet to overcome the "tragedy of the commons," and rural service providers are among the most vulnerable. This inescapable problem will almost certainly impede investment in rural broadband in an unlicensed environment.

No less problematic is the claim by some unlicensed advocates that open access to the white space would provide a way to challenge the existing broadband duopoly of cable and DSL. Unlicensed spectrum is an effective way to provide opportunistic services, such as text messaging and WiFi hot spots, for which radio links need not be always-available (no one notices if a text message is delayed by a few seconds) or pervasive in their coverage (WiFi is available in some seats in a hot-spot restaurant but not others). But key services provided by cable and DSL require reasonably reliable radio links and/or extensive coverage—capabilities that licensed spectrum can provide far better than unlicensed spectrum can. For this reason, unlicensed spectrum services have failed to put any substantial competitive pressure on the wireless telecommunications industry.

Finally, unlicensed access to the white space is deemed by its proponents to be friendly to innovation because it does not require new entrants to pay for spectrum. According to de Vries's analysis of the white space issue, "unlicensed bands allow entrepreneurs to enter a market without incurring the cash drain of obtaining a license."[31] However, the notion that free entry must be "free" reflects a misconception, as a recent critique of the commons approach explains:

> [I]t is simply not true that freedom of entry requires valuable resources to be given away without charge. On the contrary, such a giveaway approach deprives the economy of the assurance that the valuable resources will go to those who need them most urgently, as well as the other efficiency attributes for which the market mechanism is noted. In contrast, a spectrum-utilization arrangement based on auctioning of licenses is a regime of open-entry that offers those advantages. That freedom of entry does not require valuable resources to be provided without any charge to those who want to use them is easily confirmed by observation of the way in which free entry works in arenas in which it is evidently present. Surely, in no industry is entry less constrained than it is in farming. Yet to achieve such free entry it has not been necessary for land, seeds and fertilizer to be provided without charge. Entry into air passenger transportation is also

[31] de Vries, *op. cit.*, p. 18.

> unrestricted, indeed so much so that the resulting creation of new airlines threatens the viability of the incumbents. Yet it has not been found necessary to offer the entrant free aircraft or free landing slots to induce establishment of new firms. On the contrary, granting of free resources as a means to enhance entry would only invite waste of these resources and their employment by those not in a position to make the most efficient use of them.[32]

There is a more fundamental reason that an unlicensed regime is not likely to produce an optimal pattern of innovation over the long run: the benefits from investments in spectrum-conserving innovations will go to all users, not just to those who purchase the innovation:

> If manufacturer A's investment in research and development succeeds in reducing interference problems and thereby makes it possible to expand the volume of spectrum activity, only part of the resulting increase in business is likely to go to A. Much of it will also go, in the form of a beneficial externality, to equipment manufacturers B, C and D, some of whom may even be direct rivals of A. Because a substantial portion of the benefits of A's research and development expenditures go to others, it will certainly not pay A to spend as much on research and development as the public interest requires.[33]

In sum, an unlicensed white-space regime would be plagued by dual externalities: the free rider problem would discourage investment in innovation on the part of manufacturers, just as the prospect of a commons tragedy would discourage investment in infrastructure by service providers.

B. Three Key Problems with an Unlicensed White-Space Regime

For the reasons just stated, we believe that the economic and policy benefits of open access to the white space have been overstated. Three additional (and related) considerations underscore that assessment. First, technical and other factors will likely discourage the necessary investment in unlicensed systems in the short run—particularly for long-range applications. Second, given the large amount of unlicensed spectrum that already exists, the incremental benefits from an additional allocation will be limited, and the opportunity cost will be high. Third, over the long run, an unlicensed underlay will impede the evolution of the VHF and UHF bands from their current use to mobile broadband and other higher value uses.

1. Impediments to Investment

There are fundamental impediments to the use of unlicensed TV spectrum either for short-range data transfer or for long-range voice and data communications. We believe these impediments, and the chilling effect they would have on investment, would more than offset the superior propagation characteristics of this spectrum. Support for this conclusion comes in part from the

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[32] Baumol and Robyn, *op. cit.*, pp. 33-34.

[33] *Ibid.*, pp. 32-33.

recent experience with unlicensed spectrum in the PCS band and non-exclusive licensed spectrum at 3650 MHz.

Short-Range Data Transfer

For short-range data transfer, unlicensed TV spectrum would be inferior to the existing unlicensed bands at 2.4 GHz and 5 GHz. A key issue for many wireless users is the data rate. There is no assurance that more than 6 MHz of contiguous spectrum in the TV band would be available for unlicensed use at any location, and the proposed FCC rules seem to presuppose that the unlicensed device signal will be contained in 6 MHz. Thus the market would likely provide devices that operated in a single 6 MHz channel as a form of lowest common denominator. A 6 MHz channel would support data rates that are reasonably competitive with those of current wide-area services such as 5 MHz HSDPA and 1.25 MHz EV-DO channels; but it would a poor competitor to the 20 MHz channels at 2.4 GHz and 5 GHz that 802.11 devices employ.

Specifically, at short ranges—*e.g.*, within a household, where signal attenuation is not usually the limiting factor in WLAN performance—the maximum practical data rate of a TV white-space device would be only about one-third or one-quarter that of an 802.11 device operating in the current unlicensed bands. Although there are steps one might take to compensate for this limitation (*e.g.*, dynamic channel bonding), they would require more transmitters and receivers in the consumer device, and they would introduce other complexities—offsetting some of the advantages of the TV band.

Figure 5 illustrates the relative performance in terms of bandwidth and range of a wireless LAN that exploits the contiguous bandwidth available in three different locations: a white-space channel, the 2.4 GHz unlicensed band, and the 5 GHz unlicensed band. Note that both axes are logarithmic. The unlicensed band at 5 GHz is by far the widest but it has shorter range. The range at 2.4 GHz is greater than at 5 GHz, but there is only one-sixth as much bandwidth in an individual channel. The range for a wireless LAN using the white space would be longer still, but the per-channel bandwidth would be only one-tenth that of the 2.4 GHz band.[34]

[34] Figure 5 is intended to be illustrative, not exact; the values for bandwidth and range used in the figure are reasonably representative of current technology.

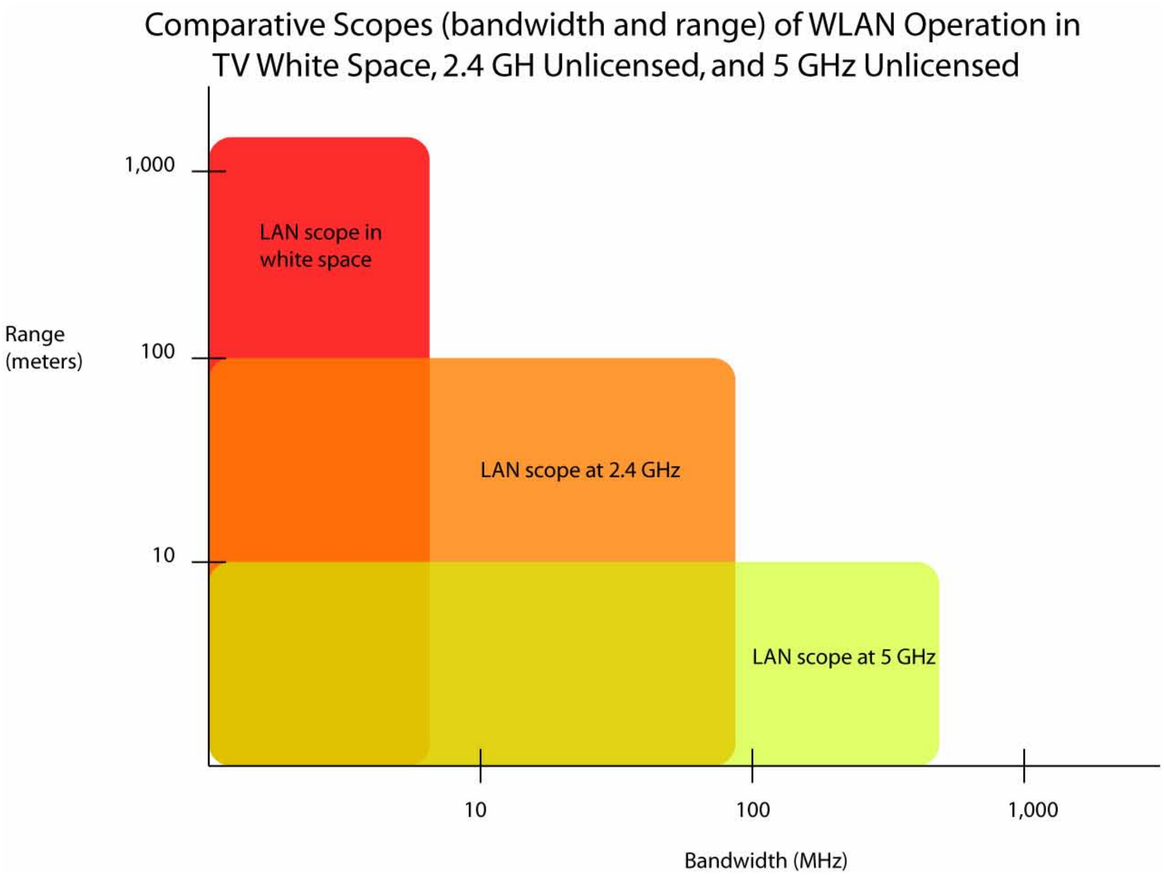

Figure 5. Scope of WLAN Services

Generally speaking, the "market niche" for unlicensed white space consists of those applications that require significant range but not significant bandwidth.[35] That is a narrow niche. In our view, for the typical user, the bandwidth advantages of the 2.4 GHz and 5 GHz bands would outweigh the range advantage of the white space. Granted, some users would buy LAN gear designed for the white space in addition to the comparable 802.11 equipment; but relatively few users would buy it in place of 802.11 equipment.

In addition to greater raw bandwidth, operations in the 2.4 GHz and 5 GHz unlicensed bands would have other advantages over comparable operations in the TV white space. For one, the higher frequencies permit units with multiple antennas to have greater antenna separation. Generally speaking, antenna separation (measured in units of radio wavelengths) is correlated with capacity.

[35] More precisely, the white space would have a comparative advantage over the 2.4 GHz and 5 GHz bands for low-bandwidth applications that require ranges greater than those achievable at 2.4 GHz and that cannot use repeaters to provide that range.

In part because they support higher data rates than other unlicensed bands, the 2.4 GHz and 5 GHz bands have spawned a huge installed base of interoperable equipment known by the name of the relevant IEEE standard (802.11). Manufacturers and users of this equipment benefit from large scale and network economies and a resulting bandwagon effect. IEEE is developing a separate standard (802.22) for the TV white space, but it is aimed at fixed wireless service for rural areas and will not target urban or in-home service.[36] Both because the 802.11 standard will remain dominant and because the 802.22 standard will be limited in scope, manufacturers will face weak incentives to develop equipment for use in the white space.

Yet another impediment to the development and adoption of wireless devices for use in the white space will be the need for those devices to protect incumbent broadcast and land mobile operations in the TV band. Most of the protective mechanisms that are under discussion (*e.g.*, beacons and geo-location) call for an additional receiver or other electronic device to be installed in the consumer white-space terminal. Supplementary electronics would add cost and reduce battery life. Even if the added cost were small, it would further reduce the ability of unlicensed wireless LANs in the white space to compete with the installed base of 802.11 devices.

In sum, the combination of limited data rates, network externalities and the added costs to avoid interference with incumbents will pose a substantial barrier to the adoption of this band for the market needs served today by wireless LANs. Similar factors, together with the FCC's complex coordination rules, fatally impaired the data portion of the unlicensed PCS (UPCS) spectrum.

To explain, the UPCS spectrum at 1910-1920 MHz had essentially the same propagation characteristics as the nearby 2.4 GHz band, which unlicensed data devices can use under Part 15 rules. However, the 2.4 GHz band is eight times larger, which permits higher data rates. The size of the 2.4 GHz band also gives users the option of changing channels to avoid interference. Those advantages, together with the fact that that unlicensed services had a several-year head start at 2.4 GHz, meant that the 2.4 GHz band could support a much larger market than the UPCS band was likely to ever generate.

The UPCS spectrum faced other problems as well. The FCC required unlicensed users to coordinate with the remaining licensed (fixed microwave) users, which added uncertainty and cost. And the FCC's complex radio-channel sharing protocol may have increased the burden on equipment suppliers.

Not surprisingly, at least in retrospect, use of the UPCS band was minimal—the lower half of the band, devoted to data, apparently received no use whatsoever.[37] In response, the Commission

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[36] Carl Stevenson, President and Chief Technology Officer, WK3C Wireless, Comments at "MSTV@50: Shaping the Future of Television," October 3, 2006. Stevenson is the chair of the IEEE 802.22 working group—the IEEE committee that is developing the 802.22 standard. See http://www.ieee802.org/22/.

[37] According to a 2004 FCC document: "The record of deployment of UPCS services, to date, has been mixed. Currently, the most widespread application of the 1920-1930 MHz UPCS band is for wireless PBX systems. However, a search of our equipment authorization database has found no UPCS equipment authorized for the 1910-1920 MHz band." FCC 04-219 at para. 12, footnote omitted.

reallocated the data portion of the unlicensed PCS band for licensed use. The reallocated spectrum will likely be used for a wireless service similar to what adjacent PCS bands support.

Unlike the UPCS band, unlicensed white space would no doubt attract users, but the likely applications would provide only modest value beyond that of those found in other unlicensed bands today. For example, the white space would support low-cost cordless phones with greater range than today's 5 GHz units, which would be useful in settings (*e.g.*, farms and university and industrial campuses) that require multiple base stations to get good coverage now. Similarly, the TV band would be useful for applications that fit naturally inside of a single TV channel, such as baby monitors and remote surveillance cameras. Because signals in the TV band do not require line-of-sight, the white space might also be attractive for moderate capacity point-to-point links such as those used to connect Wi-Fi hot spots to backbone networks or for the kind of opportunistic point-to-point links that are needed in emergencies. In sum, the white space would get used in an unlicensed regime, but those uses would likely add little value beyond what is already possible.

Long-Range Communications

Nor are we likely to see significant investment in the infrastructure necessary for long-range communications in unlicensed TV spectrum. The reason is simple: such an operation would have no protection against potential interference—either from licensed service providers or from other unlicensed operators. The risk of interference would impose a cost on unlicensed service providers that their licensed competitors, such as the licensees at 700 MHz, will not face.[38]

3.65 GHz Band: The recent experience with the 3.65 GHz band supports our view that the absence of exclusive spectrum rights discourages investment in long-range infrastructure. Under rules adopted in 2005, the FCC created a form of commons in the 3.65 GHz band: all systems operating at 3650-3700 MHz were required to adaptively "share" the band using contention-based protocols.[39]

Cisco, which manufactures short-range 802.11 systems, supports the 2005 rules.[40] However, several firms that manufacture equipment for long-range services, including Motorola, Intel and Alvarion, have petitioned the FCC to ask that it reconsider a licensed approach.[41] According to Motorola:

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[38] One of us (Jackson) participated in the due diligence investigation, by a potential investor, of an unlicensed WISP that provided service to subscribers at distances exceeding 10 miles from its antenna sites. The investor was concerned about the WISP's vulnerability to interference problems and ultimately chose not to invest.

[39] Wireless Operations in the 3650-3700 MHz Band, Report and Order and Memorandum Opinion and Order, ET Docket No. 04-151, FCC 05-56, Mar. 16, 2005

[40] Cisco, *Opposition to Petition for Reconsideration*, ET Docket 04-151, August 11, 2005.

[41] Covad, a wireless access provider that serves parts of California and Nevada, took an intermediate position; Covad said the spectrum should be licensed to control interference but that the licenses should be awarded at no cost on a first-come, first-served basis (i.e., no auction).

> …the use of a contention-based protocol among multiple unaffiliated users will not allow rapid deployment at 3650 MHz nor offer the most efficient use of the spectrum, particularly in dense urban areas….The combination of exclusive licensed use along with flexible technical standards and secondary market leasing provisions will offer the most efficient and rapid deployment of wireless broadband services across the U.S. using this new band.[42]

The WiMAX Forum, which stressed the importance of quality of service for providers deploying long-range wireless broadband technologies, was even more direct, predicting that "'tragedy of the commons' problems are likely to be severe in large urban areas."[43]

Cisco maintains that the position taken by manufacturers of long-range equipment reflects their financial interest in WiMAX, which is suited to licensed spectrum. But it goes without saying that the manufacturers are self-interested; the same can be said of Cisco. What is significant about the manufacturers' position (and it is consistent with their decision to invest in WiMAX, more broadly) is that it reflects a belief that interference will suppress equipment sales.

Many service providers have also weighed in to say that the current FCC rules will produce interference and that there is no easy or efficient way to control interference in an unlicensed environment. For example, TDS Telecom, which serves more than 900 rural and non-urban communities in 28 states, urged the FCC to adopt a licensed approach in place of contention-based protocols, which it views as "insufficient guards against harmful interference:"

> Deployment of wireless broadband requires investment in equipment, software, labor, marketing and other resources. TDS Telecom cannot take the risk that its wireless network will be rendered useless in 5-10 years due to limitless entry into the band.[44]

The Wireless Internet Service Providers Association (WISPA), although formally supporting the FCC's 2005 rules, submitted comments that appear quite critical of aspects of the unlicensed rules. WISPA refers to the "aggressively inefficient system designs that we've seen all too often under the current rule structure." WISPA also raised questions about how the interference that its comments imply is inevitable will be handled:

> We're also worried about the lack of channel planning. What happens when an inefficient radio system bumps into a highly efficient one and keeps the "better" one from operating. When a system using 5 MHz of spectrum and a system using 25 MHz want the airspace at the same time which gets to go?[45]

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[42] Motorola Petition for Reconsideration, ET Docket No. 04-151, June 10, 2005.

[43] WiMAX Forum, ex parte comments, ET Docket 04-151, June 28, 2006.

[44] TDS, ex parte comments, ET Docket, 04-151, February 14, 2006.

[45] Ex parte letter in ET Docket No. 04-151, August 3, 2005. WISPA suggested rules that would promote efficiency and limit the amount of spectrum any one operator could use. WISPA's point—that unlicensed rules do not provide for priority of one user over another—is a fundamental one. Although WISPA doesn't

Other Interference Scenarios: In addition to the kind of unintentional interference at issue in the 3650 MHz proceeding, the TV band could well be plagued by "strategic" interference. Consider a licensed wireless access provider (Firm L), and an unlicensed competitor that operates in the TV band (Firm U). Firm L offers its subscribers wireless LAN devices that use the white space. As an "unfortunate" side effect, those devices create interference that degrades the service of nearby customers of Firm U.

Other unintended scenarios are not hard to imagine. Under current FCC rules, Firm L could apply for a license for a TV translator or low-power TV station and locate the station transmitter near one of Firm U's base stations. Firm U would be obliged to quit operating on the channel on which Firm L had located its transmitter because it would no longer be considered white space.

Alternatively, Firm L could perform a "public service" by installing a one-watt unlicensed white space device either to retransmit TV signals or to transmit information such as weather forecasts using the ATSC format. If the unlicensed unit was installed near a base station receiver, Firm L's white space device would jam the desired signals from Firm U's subscribers.

Another conceivable scenario involves a community broadcaster that employs the white space to offer an unlicensed TV service. If the service were to use ATSC transmissions and on-channel repeaters, viewers would be able to pick up the signal with their over-the-air TV antenna. If, in addition, a manufacturer were to develop low-cost repeaters for such a service, it would consume a significant amount of the available white space. Granted, over-the-air TV would probably not be a very efficient way to provide such a service, but the provider might be someone who entered community broadcasting for pleasure rather than profit.

Unlicensed operation in the white space—in addition to creating interference for individual unlicensed users—also runs the risk of raising the noise floor in the white space—particularly in the UHF bands. The current unlicensed bands at 900 MHz and 2.4 GHz have experienced a substantial rise in noise levels above thermal noise. A comparable rise in the UHF noise floor—due to, say, cordless telephones—would impair the operation of long-range unlicensed systems.

2. Diminishing Incremental Benefits, High Opportunity Cost

The standard "pitch" for open access to the white space cites the large benefits that unlicensed spectrum in the 2.4 GHz band has produced, and then asserts that additional allocations of unlicensed spectrum will produce more of the same. The implicit logic is a kind of straight-line extrapolation: if X is good, then two X is twice as good. For example, Dell refers to the white space as "a multi-billion market, just waiting to explode, if next-generation home and office wireless networking devices are enabled in the white spaces."[46]

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acknowledge it, the logical solution is a system of licensed rights, which provide protection against interference.

[46] Dell, ex parte letter in ET Docket 04-186, January 12, 2007.

However, this reasoning fails to isolate the *incremental* value of an additional allocation of unlicensed spectrum—*i.e*, those benefits that would not arise *but for* open access to the TV band. At the same time, it ignores the (incremental) opportunity cost of such an allocation.

Incremental Benefits

A large amount of spectrum has already been allocated for unlicensed use—a fact that unlicensed advocates tend to downplay. Table 2 shows the major allocations of unlicensed spectrum that permit "high-power" operations. (We have excluded those unlicensed bands that are limited to very low-power operations. Note also that a wide variety of unlicensed uses, such as medical telemetry and automobile radar, take place outside the bands listed here.). Table 2 shows that approximately 11 GHz of spectrum is available for unlicensed use, which represents more than ten percent of the entire spectrum below 100 GHz. Looking just at the lower range, 760 MHz of the spectrum below 6 GHz—or about 13 percent—is available for unlicensed use.

The supply of unlicensed spectrum is large not just in absolute terms, but by comparison to that of liberally licensed spectrum—that is, the bands such as cellular and PCS that permit substantial technical and economic flexibility. Moreover, until recently, the large blocks of unlicensed spectrum the 5 GHz band had seen relatively little use, although that has begun to change.

Because the existing supply of unlicensed spectrum is large, additional allocations of unlicensed spectrum will likely provide diminishing returns—contrary to what the claims made by unlicensed advocates imply. Recall our earlier conclusion that the likely short-range applications of the white space would provide only modest value beyond that of those found in other unlicensed bands today.

The persistent claim that unlicensed white space will stimulate significant innovation is similarly overstated. Granted, unlicensed use of the 2.4 GHz band spawned WiFi and other major innovations. However, there is little if any evidence that additional unlicensed spectrum will create significant *new* opportunities for innovation, given the large supply that already exists.

In response to the diminishing-returns charge, unlicensed advocates stress the unique advantages of the spectrum below 2 GHz, of which only 26 MHz permits unlicensed operation at relatively high powers. In effect, they redefine the relevant universe of spectrum, excluding what they call the "nosebleed bands" where most unlicensed activity takes place. But low frequency is not always a plus (recall our earlier observation regarding antenna separation). Even where it is a plus, other attributes matter as well, as shown by our conclusion that the bandwidth advantage of the unlicensed bands above 2 GHz will outweigh the other advantages of the less-plentiful white-space spectrum in many cases.

Table 2

Major "High-Power" Unlicensed Spectrum Allocations			
Block	**Bandwidth (MHz)**	**Power Limit (watts)**	**Comments**
902-928 MHz	26	1	
2400-2483.5 MHz	83.5	1	
5725-5850 MHz	125	1	
24.0-24.25 GHz	250	Limit is on field strength, not power.	Power limit in FCC rules is given as a field strength limit (2500 mv/m at 3 meters, see 47 CFR 249). Maximum power varies with antenna size.
57-64 GHz	7 GHz	0.5	At these high frequencies, radio waves typically require a line-of-sight path from transmit antenna to receive antenna. This band is a resonance of the O_2 molecule and cannot be used for long-range applications.
92-95 GHz	3 GHz	0.5	Limited to indoor use.
1920-1930 MHz	10 MHz	Varies with bandwidth	Unlicensed PCS band. Of little utility
5.15-5.35 GHz, 5.47-5.725 GHz 5.725-5.825 GHz	200 MHz 225 MHz 100 MHz	Varies. The maximum is 1 watt.	The band 5.15-5.25 GHz is restricted to indoor use.
Total	11.0195 GHz		
Total below 6 GHz	759.5 MHz		Excludes unlicensed PCS band (10 MHz)

As another counter to the diminishing-returns argument, unlicensed proponents point to the growing demand for (unlicensed) low-power wireless networks. However, the fact that demand is growing for devices that operate in unlicensed spectrum does not necessarily imply that an additional allocation of unlicensed spectrum will yield benefits. Because unlicensed spectrum is a public good, it is difficult to determine what the benefits from an incremental increase in supply would be. Policymakers routinely calculate the benefits of an incremental increase in public goods such as national security or highway safety as part of the budget process. But unlicensed spectrum is different in that the government can make allocate it at no real cost—*i.e.*, without having to face the real opportunity cost.

An Economic Framework for Analyzing Benefits: Coleman Bazelon, an economist and spectrum expert with The Analysis Group, recently developed an economic framework for the very task at hand—analyzing the incremental value of an unlicensed versus a licensed allocation of spectrum in the TV band, given existing allocations.[47] Bazelon's key insight is that an incremental allocation of unlicensed spectrum would create value solely through its effect on externalities. The major effect would be congestion relief: unlicensed spectrum generates congestion because users do not internalize the cost that their use of the spectrum imposes on others; an allocation of additional unlicensed spectrum could reduce that cost. Bazelon points to innovation as a second externality effect.

Bazelon argues that, given existing allocations, an additional allocation of unlicensed spectrum will not lead *directly* to any increase in consumer surplus (the externality effect will produce an indirect increase in consumer surplus). The logic is straightforward: consumption of unlicensed spectrum and related goods is not constrained by its availability; thus, an increase in the amount of unlicensed spectrum does not generate any consumer surplus.

Bazelon estimates that the marginal value of an unlicensed allocation of TV white space is about $12 million per incremental MHz. This is accounted for solely by congestion relief.[48] (Bazelon acknowledges that there is some positive effect on innovation, but does not have any basis for

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[47] Coleman Bazelon, "Licensed or Unlicensed: The Economics of Incremental Spectrum Allocations," Paper Presented to the Telecommunications Policy Research Conference, September 29-October 1, 2006, Washington, DC. In a related context, Hazlett and Spitzer argue that a marginal analysis is necessary but not sufficient to support an allocation of additional unlicensed spectrum. In their view, before deciding how to allocate additional spectrum, we must estimate what wireless values would be under different rules. Their key point is that the expected value of a property regime would encompass many, if not all, of the spectrum use options permitted unlicensed users because the flexible use regime allows licensees to innovate over business models and market structures. Or, as they state it, "If the kinds of 'open access' rules characteristic of unlicensed bands are efficient, then exclusive spectrum rights holders will have strong incentives to adopt them." Thomas W. Hazlett and Matthew L. Spitzer, "Advanced Wireless Technologies and Public Policy," *Southern California Lew Review* 79 (March 2006).

[48] Of that amount, $5 million is due to reduced congestion in the home, and $7 million to reduced congestion for wireless internet service providers (WISPs), who typically operate in rural areas. (The $7 million is based on the average price paid for spectrum rights in rural areas in the recent AWS auction; Bazelon reasons that AWS license values represent an upper bound on what reduced congestion is worth to WISPs at the margin.) Bazelon does not assign any marginal value to congestion relief in public, since he can find no documented evidence of congestion of public WiFi hotspots outside of convention centers.

quantifying it.) This is less than 10 percent of the incremental value he assigns to a licensed allocation of the same spectrum (Bazelon values a licensed white-space allocation at $152 million per incremental MHz—the average price paid for spectrum in the recent AWS auction).

Opportunity Cost of Unlicensed White Space

Most property rights advocates will acknowledge that enormous benefits have come from the decision to allow unlicensed activity in what was a "garbage band" at 2.4 GHz. But it does not follow that the FCC should pursue the same policy in the TV band—another so-called "junk band"—as unlicensed advocates assert. The difference is opportunity cost.

The opening of the 2.4 GHz band to unlicensed activity did not displace or preclude any licensed activity: the 2.4 GHz band was already reserved for unlicensed use by Industrial, Scientific and Medical (ISM) equipment, such as microwave ovens, which precluded most (high-power) licensed uses—hence the term "garbage" band. In short, unlicensed access to the 2.4 GHz band did not impose any meaningful opportunity cost. By contrast, a decision to open the TV white space to unlicensed activity would preclude licensed activity in the same spectrum, imposing a direct opportunity cost.

In Section V, we discuss the merits of a licensed approach to the white space and argue that its benefits—*i.e.*, the opportunity cost of an unlicensed approach—are significant (among other things, we estimate that an FCC auction of the white-space spectrum rights would generate several billion dollars). But what interests us here is the question of why, given these large potential benefits, the licensed approach been largely ignored in the policy debate.

A major factor may be the perception that licensed access to the white space is not technically or commercially feasible—largely because of high transaction costs. We believe this is a misperception, as we noted earlier, and we will address it in detail in Section V.

Another rationale used to dismiss the possibility of a licensed approach is equally flawed. At a recent conference on spectrum reform, when a speaker representing one of the high-tech firms prominently supporting unlicensed white space was asked why his company did not support licensed access, he responded that it was not politically feasible—an apparent reference to the fate of the Pressler plan and broadcasters' clout with Congress and the FCC. That assessment is out-of-date, however. In part because unlicensed advocates have been so politically effective, it appears likely that Congress and/or the FCC will allow access to the TV white space on some basis. Recognizing that, broadcasters have signaled their preference for a licensed regime because it would provide better mechanisms to control interference than an unlicensed regime.

Yet another rationale is that licensing of the white space is unrealistic because it would take too long. That too is a red herring: the FCC has indicated that it would not allow unlicensed use of the white space during the DTV transition, which ends in early 2009. Two years should be enough time to determine license terms and hold an auction.

In short, a market-based approach to the white space should no longer be dismissed as a non-starter for economic, political or administrative reasons. Since licensing of the rights to vacant TV channels is a viable option, unlicensed access would impose a genuine opportunity cost.

3. Squatters Rights and the Future of the TV Band

Allocation of the TV white space for unlicensed use, and the regulatory controls that would entail, could create a powerful constituency, consisting of tens of thousands of spectrum "squatters" and hundreds of technology and equipment suppliers. Such a constituency would impede the long term transition of the TV band just as surely as dense foliage blocks a high frequency radio wave.

The major problem with traditional FCC spectrum regulation has been its tendency to promote rent-seeking in place of entrepreneurial innovation. As just one example, low-power TV was approved only decades after it was technically feasible, because of resistance by broadcasters.

An unlicensed regime in the white space would be no less susceptible to rent-seeking than the current regime because it relies on government-set rules, as opposed to market forces—what unlicensed advocates call "light regulation." The political economy of regulation is almost as predictable as the physics of spectrum. One iron rule of regulation is that it is hard to take things away from identifiable groups. In addition to creating an incentive for the recipients of concentrated benefits to organize, regulation provides countless opportunities for them to use the courts, the Congress and the administrative process to engage in tactical delay and to distort the policy process in their favor. Thus it provides the ideal terrain on which vested interests can defend the *status quo* and resist the efforts of those who seek to impose a new order.

To their credit, unlicensed advocates have been highly critical of the perverse effects of legacy spectrum regulation: early support for the unlicensed approach was in part a response to the difficulty of bringing spectrum-using innovations, including end-user equipment, to market in a command-and-control environment. Many unlicensed advocates no doubt believe that the creation of a spectrum commons will avoid the creation of vested interests that will oppose change. But history tells us otherwise, as a recent critique of the commons approach to spectrum management explains:

> After all, those who take advantage of the opportunity to make use of a common property will be no more willing to give up that use voluntarily than if they had been required to pay for the privilege. The experience from the reign of Henry VIII to the 18th century of the closure movement undertaken to close down the medieval commons surely shows that this arrangement is no way to avoid the creation of vested interests. Faced with the loss of their means of livelihood, poor farmers and laborers put up a ferocious resistance to the closing of the commons that continues to be noted by historians.[49]

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[49] Baumol and Robyn, *op.cit.*,pp. 51-52.

Recent experience is a reminder of the power of spectrum squatters. The 902-928 MHz band is used for Navy radars, but has also supported a growing number of unlicensed systems that are, in theory, secondary to authorized operations. As these unlicensed activities expanded, the two sets of operations began to conflict: when Navy personnel fired up the radars on Navy ships that were in port, primarily to repair and maintain them, the radars interfered with (civilian) cordless phones. Predictably, the civilians complained to Members of Congress and other policymakers. Eventually, the Navy restricted its use of radars while in port.

Granted, it is difficult to take spectrum away from any group. But liberally licensed users are more likely to adjust to changes in technology and tastes on a continuing basis. Companies like Verizon Wireless and AT&T have seamlessly upgraded their networks and user handsets to new, more efficient digital standards, at a total cost of many tens of billions of dollars. Contrast that with the broadcasters, who have little if any incentive to use the spectrum more productively: technical standards were essentially static from the adoption of color TV in the 1950s until the current move to digital television. During that same period, the performance of TV cameras and TV sets expanded enormously, due to innovation by unregulated manufacturers.

Like broadcasters, unlicensed users of the white space would have no incentive to use the spectrum more efficiently. This is the irony of the claim that the TV band is suited only for unlicensed activity because it is a "junk band." If the TV is a "junk band," it is largely because of the perverse incentives created by a rule-based regulatory regime—the same perverse incentives that an unlicensed approach would perpetuate. Thus, unlicensed advocates are citing the damage done by command-and-control regulation to justify another regulatory regime that would bring more of the same.

Spectrum-Sensing Technology and Other Special-Interest Scenarios

Consider one possible way (there are many) in which unlicensed users might impede the evolution of the TV band to higher value uses. Some experts have proposed that unlicensed devices use spectrum-sensing technology as a way to avoid causing harmful interference to broadcasters: the technology would detect broadcast signals and identify vacant spectrum by the absence of broadcast signals. However, a mechanism designed to detect ATSC TV signals and wireless microphones would no longer serve its desired purpose of detecting TV transmissions if broadcasters allowed to operate with technical flexibility—*i.e.*, if they were authorized to use alternative modulation technologies. That failure would occur because the alternative signals would be unlikely to match the signals that the sensing mechanisms were designed to detect.

It is easy to envision how this might play out. Under one scenario, the prospect of the spectrum-sensing technology being rendered useless could become an impediment to broadcasters getting technical flexibility. In this way, broadcasters could get locked into their existing technology. Alternatively, if the technical standards were changed, the unlicensed devices would be able to invade the non-white-space portions of the TV band. Under either scenario, unlicensed devices would lock the white space into an inefficient pattern of use for decades, and the FCC would lose its flexibility to facilitate more efficient use of the rest of the TV band.

Spectrum-sensing technology is merely an example; in an unlicensed regime, special interests will seek to block the kind of efficient change that would occur naturally in a market-based regime. The clash in this white-space proceeding over the treatment of wireless microphones provides a preview. There are a relatively small number of wireless microphone systems licensed by the FCC and a larger number operating on an unlicensed basis. However, wireless microphone manufacturers have organized a "Microphone Interests Coalition" to persuade the FCC that "the white spaces are not really white at all."[50]

As another example of regulatory "squatting," the burglar alarm industry, which uses cellular spectrum, is currently urging the FCC to require that the older, inefficient analog wireless systems operated by firms such as Sprint be maintained. The alternative would require the alarm industry to buy new terminal equipment.[51] If the alarm industry succeeds, it will benefit slightly, but all other users will be harmed as wireless carriers are forced to incur higher costs and delay the rollout of 3G wireless technologies.

Technical Fixes Cannot Remove the Political Impediment

Modern technologies do offer some promise of moderating the effects of the squatter's rights problem. One possible technological "fix" would be for the FCC to require that unlicensed devices operate with some form of positive control based on up-to-date data that described the limits on permitted operations. For example, the FCC could publish a database describing which geographic locations and frequencies and at what powers devices unlicensed devices could operate. Devices would be required to cease operation unless they had recently downloaded a new copy of the data base from a server run by the device manufacturer. Devices would also have to contain some form of geo-location subsystem (*e.g.*, a GPS receiver) that they could use in conjunction with the database in order to determine allowed operations.[52]

Positive beacons—signals that an unlicensed device must receive before it can operate—are another technique to provide similar control. One can imagine other incremental removal policies. For example, the maximum power that an unlicensed device could use could be ramped down over time on some channels or in the entire band.

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[50] Ex parte notice of Microphone Interests Coalition, ET Docket 04-186, January 26, 2007.

[51] See "Wireless Telecommunications Bureau Seeks Comment on Petition for Rulemaking to Extend Cellular Analog Sunset Date," RM No. 11355, Public Notice, DA 06-2559 (Dec. 20, 2006).

[52] A database-controlled positive authorization system like this would allow the FCC to rapidly clear portions of the white space for other uses. For example, suppose the FCC determined that the white space on TV channels 21-30 were to be made available for public safety use in the ten largest cities. The FCC could modify the database to prevent operation of unlicensed devices in those channels in the proper areas. Almost immediately, the unlicensed devices in the affected geographic regions would restrict their operation to channels other than 21-30. If most devices checked in moderately frequently—say once every two months—then in just a few months the unlicensed devices would have been removed from that spectrum. In contrast, if the regulatory solution were more traditional, outlawing new devices but grandfathering the old devices until they are retired, then it would take many years before the relevant spectrum regions were cleared.

In short, there may be technological "fixes" to the squatter's problem. But the impediment will be political, not technical. If unlicensed use of the white space is only modestly "successful" in terms of attracting users, it will create special interests primed to fight against more efficient use of the white space.[53] If there is no political will to use them, then these technological options will not matter because they will never be exercised. History shows that that political will is likely to be lacking even if removing unlicensed operations from the white space would create benefits far in excess of the costs it would impose on the white space users and manufacturers.

[53] As discussed earlier, we fully expect the white space to attract users; our concern is that the applications will not add significant value beyond those available on other unlicensed bands today. However, consider the alternative—namely, that unlicensed white space, like the unlicensed PCS band, attracts almost no users and the FCC reallocates the spectrum for licensed use. In that case, squatters will not be a problem, but the potential of the white space will have been squandered for a decade.

V. LICENSED USE OF THE TV WHITE SPACE

Summary: A licensed approach to the white space offers three key advantages over an unlicensed approach. First, it should produce more efficient use of the white space, even in the short-run: most important, the parties—the potential interference-generating licensee and the potentially interfered-with broadcaster—would have an incentive to negotiate deviations from FCC interference standards, resulting in greater capacity. Second, licensed access would encourage investment in long-range infrastructure by protecting the licensee against interference from other white-space operations. Third, in the long-run, licensed access would facilitate, not impede, the evolution of the TV band to higher-value uses. Although unlicensed advocates dismiss the licensed alternative on the grounds that the coordination costs would be prohibitive, the FCC generally structures overlay licenses with an eye to limiting those costs, and the white space is not fundamentally different. Below, we describe the licensed option and discuss its key advantages. Next, we address questions about the feasibility of the licensed option. Finally, we estimate what an auction of the white-space spectrum rights would generate in revenue.

A. How Would it Work?

Under this option, the FCC would allocate all spectrum in the TV band (channels 2-51, except 37) to one or more licenses and assign them using an auction or other market mechanism. These exclusive and tradable rights would allow a licensee to use the spectrum in any way desired as long as the usage rights of existing license holders (broadcast and land mobile operators) were protected. Consistent with FCC rules governing analogous situations, a white-space licensee and an incumbent broadcaster would be able to negotiate variations from FCC interference standards.

Potential Applications

Key characteristics of the white space will determine its likely use in a licensed regime:

- Adequate spectrum to support nationwide service but limits on bandwidth in some areas
- Superb propagation characteristics, allowing for reduced capital expenditure
- Spectrum is unpaired, but enough spectrum under some scenarios for dynamic pairing
- Proximity to broadcasters will require additional engineering near the edges

The white space would lend itself to the same high-demand applications that wireless services offer today. That portion of the white space that is nationwide in scope could potentially support broadband PCS, including fixed and mobile voice and data. More generally, the white space could support broadband Internet access, both fixed and mobile. A licensee might offer such a service using white space only or using the white space as a complement to other spectrum.

In addition to (or instead of) operating its own service, a white-space licensee might serve as a band manager—providing sublicenses to spectrum users. The fact that white space will be more plentiful in some areas than others would make this an attractive business strategy. For example, a nationwide white space licensee whose business plan required 12 MHz of spectrum in the primary service area would have additional capacity available in the less dense markets—capacity that could be valuable to someone with a different business plan.

Structure of Spectrum Rights

The range of services that the white space will support depends in part on how the spectrum rights are defined. Two dimensions of those rights will be key. One is the amount of bandwidth covered, which could range from 6 MHz to the full TV band (6 MHz is the natural building block for a white space license, given the channelization of TV, and it is probably the minimum necessary to support commercial service). The other key variable is geographic coverage, ranging from small regions to the entire nation.

Generally speaking, licenses that offer broad coverage along both dimensions promote economic efficiency. First, interference control among licensees is easier if there are fewer boundaries. In the extreme case, in which just one licensee controls all the relevant spectrum, coordination is fully internalized—*i.e.*, it all takes place within the licensee-firm. Second, broader coverage affords more commercial options: with wider channel coverage, a licensee is more likely to have sufficient spectrum in dense urban areas; and a license that covers the full country gives a new entrant the option of offering nationwide service.[54] Nationwide licensing is particularly important for new entrants that want to use a new technology that cannot "roam" onto existing networks. Finally, broad coverage allows for economies of scale in equipment procurement and marketing.

With these efficiency considerations in mind, economists typically argue that overlay licenses should provide nationwide geographic coverage and enough bandwidth to permit a variety of uses and to achieve economies of scale.[55] The Pressler plan is an example of that: it called for five nationwide overlay licenses, which would have given each licensee the (nationwide) rights to a subset of channels in the TV band.

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[54] Nationwide licenses are nothing new. The FCC has granted nationwide licenses (*e.g.*, the recent the G-Block license to Nextel), and several wireless carriers have aggregated smaller licenses to achieve national coverage (had PCS licenses been auctioned off on a nationwide basis, carriers could have avoided substantial transactions costs).

[55] See for example, Evan R. Kwerel and John R. Williams, "Moving toward a Market for Spectrum, *Regulation* (Spring 1993). Purely on efficiency grounds, the optimal package of spectrum rights for the white space would be a single nationwide overlay license covering all 49 channels. For the reasons discussed above, such an approach would minimize the transaction costs and maximize the commercial opportunities associated with operating in the white space. Unlicensed advocates dismiss that idea on the grounds that it would be unacceptable to rural interests and raise competition concerns. The latter concern, at least, is misplaced: a single-license approach would not be anti-competitive, because a white space operator would face competition from the many existing wireless operators as well as some terrestrial and satellite service providers.

However, efficiency is not the only consideration, and smaller licenses tend to be more affordable—a key consideration for smaller providers. The FCC generally auctions off regional licenses of various sizes in an effort to accommodate a range of would-be licensees. Large providers can and do aggregate smaller licenses to achieve national coverage.

Similarly, for the white space, less aggregated approaches to packaging spectrum rights would be entirely feasible. Instead of a nationwide license, the FCC could auction overlay rights to the (entire) band in each of a number of *smaller geographic regions*, such as the 52 Major Economic Areas or the 6 Economic Area Groupings used in PCS auctions. Alternatively, an overlay license could cover just a *subset of all channels,* with the subset chosen such that at least 12 MHz of white space was available for 95 percent of the covered population.[56] Corresponding geographic coverage could be either national or regional. Although 12 MHz is an arbitrary threshold, it would ensure a minimum capability at every location in the license area.

An alternative to an overlay would be to license the *"doughnut" around individual TV stations*, as shown in Figure 6. Doughnut licenses are more restrictive than the broader licenses discussed above because each white space license is paired with a single TV station. The advantage of this approach is that the new license is a natural complement to the incumbent one; when combined, the two create an area license.[57]

Doughnut licenses make sense if broadcasters are the entities most likely to buy the rights to the white space—presumably, as a way to expand their station coverage: such licenses would allow TV stations to internalize the transaction costs associated with coordinating interference control and thus promote efficient use of the white space. Alternatively, if broadcasters were to be given the right to offer non-broadcast services, doughnut licenses would facilitate the evolution of the TV band to higher value applications. However, absent one of those two scenarios (neither of which seems likely at present), a broad overlay license—one that spans many channels in bandwidth and multiple cities in geographic coverage—would probably make more sense.

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[56] For example, a license might cover channels 38-51, or channels 22-25 and 44-51.

[57] There are alternative techniques for defining a doughnut license. One technique for defining the scope of a doughnut license would be to identify mathematically that set of locations that is closer to a specific TV station than to any other TV station on that channel. Alternatively, one could draw the geographic boundaries of the doughnut license along the boundaries of the corresponding station's designated market area (DMA). The latter approach is probably preferable because it would produce an area license that was better suited to the commercial and contractual environment facing a particular station.

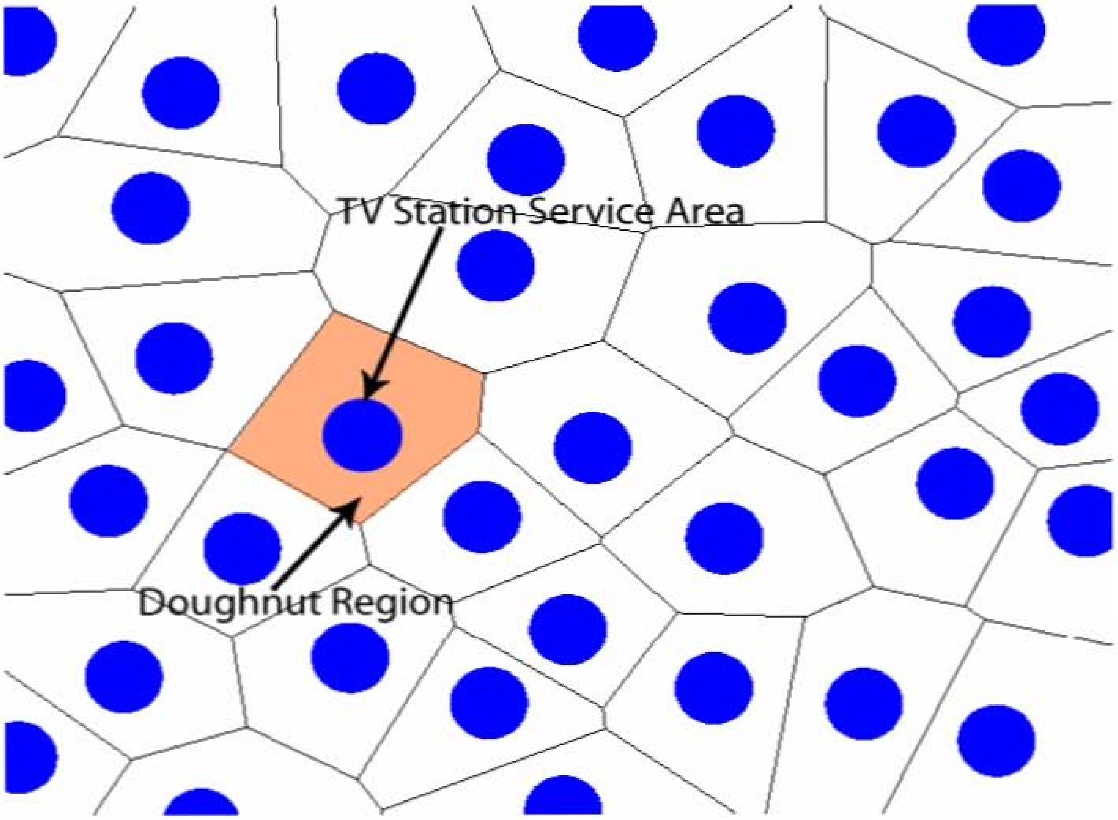

Figure 6. TV Station Service Areas and Associated Geographic Regions for White Space Licenses

Precedent for White-Space Auctions

The FCC has conducted at least fourteen auctions of what amounted to white space outside of the TV band. (See Table 3.) These auctions, which generated more than $1 billion, illustrate a variety of approaches to the structuring of spectrum rights. In Auction 53, the FCC awarded overlay rights to 500 MHz of spectrum (12.2-12.7 GHz) in 214 geographic service areas to be used for terrestrial broadband services; the incumbent licensees that had to be protected were direct broadcast satellite (DBS) service operators and point-to-point public safety microwave systems. In that auction, the FCC explicitly contemplated overlay operations similar to those discussed above. According to the Commission:

> MVDDS licensees may use this spectrum for any digital fixed non-broadcast service (broadcast services are intended for reception of the general public and not on a subscribership basis) including one-way direct-to-home/office wireless service. Licensees are permitted to provide one-way video programming and data services on a non-common carrier and/or on a common carrier basis. Mobile and aeronautical services are not authorized. Two-way services may be provided by using other spectrum or media for the return or upstream path.[58]

[58] Auction 53 Fact Sheet. Available at

Table 3

Table A1. FCC "White Space" Auctions

Auction	Radio Service	Net Auction Bids	Notes
6	BRS (MMDS)	$216,316,333	
7	900 MHz SMRS	$204,267,144	Licensed as paired 0.125 segments
16	800 MHz SMRS	$96,232,060	Licensed in blocks of 1, 3 or 6 MHz
26	929 and 931 MHz Paging	$4,122,500	
34	800 MHz SMR General Category	$337,494,900	
36	800 MHz SMR Lower 80 Channels	$28,978,385	
40	Paging	$12,897,127	
42	Multiple Address Systems	$1,202,725	
53	Multichannel Video Distribution and Data Service (MVDDS)	$118,721,835	DBS “white space.” Of the fixed microwave incumbents in this spectrum, only public safety incumbents were protected against interference from the white space licensees.
55	900 MHz SMRS	$4,861,020	Licensed as paired 0.125 segments
57	Automated Maritime Telecommunications System (AMTS)	$1,057,365	
59	Multiple Address Systems	$3,865,515	
61	Automated Maritime Telecommunications System (AMTS)	$7,094,350	
63	Multichannel Video Distribution and Data Service (MVDDS)	$133,160	DBS "white space"
	Total	$1,037,244,419	

All information in the above table was taken from the FCC’s Auction web site—specifically the *fact sheet* pages for each auction.

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http://wireless.fcc.gov/auctions/default.htm?job=auction_factsheet&id=53

In other cases (*e.g.*, Auctions 34, 36 and 55), the overlay rights packages covered a subset of the total band in 175 separate geographic regions. In practice, these licenses were much like the doughnut licenses described above; Nextel, which had the rights to the "hole" in the doughnut in most of those regions, won the auction, and thus was able to convert its site licenses to more efficient area licenses. The FCC described the protection to be afforded to incumbents by the winners of Auction 34:

> Incumbent licensees are present in the 800 MHz SMR band. Incumbent 800 SMR systems are entitled to co-channel protection by EA licensees, as well as adjacent channel interference protection. Incumbent systems, however, are not allowed to expand beyond existing service areas unless they obtain the EA license for the relevant channels.[59]

One Approach to Licensing Regions

The Commission asked for specific proposals for license regions and band plans (FNPRM, para. 4). As discussed above, larger license regions better serve efficiency, generally speaking. We believe that there is a strong argument to be made for a single nationwide license for the entire white space. Such a license would provide a new entrant with sufficient spectrum to provide a nationwide service of reasonable capacity and it would also eliminate any interference coordination costs among white-space licensees.

However, we recognize that there are countervailing values in addition to pure efficiency. Consequently, we propose a variety of geographic and bandwidth regions. As the FNRPM notes there are natural subdivisions in the TV spectrum that provide natural boundaries for licensing. We follow these natural boundaries in our recommendations which are shown in Table 4. We also recommend that the Commission use combinatorial auctions or some other form of package bidding that would allow new entrants to avoid circumstances in which they were locked into purchasing less than the necessary coverage for a new service.

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[59] FCC Fact Sheet for Auction 34. Available at: http://wireless.fcc.gov/auctions/default.htm?job=auction_factsheet&id=34.

Table 4

One Approach to Licensing Regions	
TV Channels	**Geographic Regions**
2-6	734 Cellular Market Areas
7-13	176 Economic Areas (EAs)
14-36	12 Regional Economic Area Groupings (REAGs)
38-51	12 Regional Economic Area Groupings

B. Advantages of Licensed Operation

Licensed use of the white space offers both short-run and long-run advantages over unlicensed use. Either set of advantages provides reason enough to opt for a licensed approach.

1. Promotes Efficiency in the Short Run

More Efficient Use of the White Space: Licensed use of the white space would promote greater efficiency than unlicensed use even in the short run. Perhaps most significant, licensed white-space systems could be engineered-in more closely to the edges of broadcast coverage than unlicensed system, creating significant additional capacity. This would be possible because of more flexible interference rules as well as the incentives that property rights would create for negotiation beyond those rules.

To elaborate, in a licensed environment, if white-space operations created an interference problem, a broadcaster could identify the source of the interference and deal with the interferer—either directly or through the FCC. In an unlicensed environment, both tasks would be more difficult. As a result, the FCC would be likely to impose—and broadcasters would be likely to accept—less protective interference standards for licensed white-space operations than for unlicensed operations.

Moreover, assuming the rules permitted it, broadcasters and the white-space licensee could bargain about deviations from those standards. For example, the licensee could purchase the right to operate on the edge of the broadcaster's coverage. One can envision other agreements between a white space licensee and a broadcaster that would permit much tighter system engineering than would be possible under the rules.

Neighboring licensees can negotiate such variations under current FCC rules covering broadcast, PCS and cellular operations. For example, the FCC's broadcast rules (47 CFR 73.6022(a)) state:

> Class A TV stations may negotiate agreements with parties of authorized and proposed analog TV, DTV, LPTV, TV translator, Class A TV stations or other affected parties to resolve interference concerns; *provided*, however, other relevant requirements are met with respect to the parties to the agreement. A written and signed agreement must be submitted with each application or other request for action by the Commission. *Negotiated agreements under this paragraph can include the exchange of money or other considerations from one entity to another*. Applications submitted pursuant to the provisions of this paragraph will be granted only if the Commission finds that such action is consistent with the public interest. (emphasis added)

To be sure, a broadcast station could not agree to incursions by a white-space operator that would significantly harm broadcast coverage and jeopardize the public service benefits provided by its license. But it is easy to envision "win-win" agreements between the two parties with respect to operations on the edge of the broadcaster's coverage—especially if broadcast service was unavailable in any event in the affected area (*e.g.*, due to terrain blockage that was not reflected in the calculation of the station's protected contour) or if the only people whose coverage was affected were those traveling in cars. Moreover, public service benefits can take different forms: a broadcaster might grant a white space operator additional operating flexibility in exchange for revenue that would be used to harden the broadcast facilities, thereby providing enhanced emergency service.

Experience demonstrates the benefits of such negotiated agreements among licensees. Research by an FCC engineer, John R. Williams, showed that "frequency coordination" among microwave operators produced much more tightly engineered systems—with resulting higher capacity—in the northeast, where demand for spectrum was higher than in other areas of the country.[60] Currently, a similar process in the 700 MHz band is helping to facilitate the digital TV transition.

In sum, a licensed regime would create the opportunity and incentive for broadcasters and white-space operators to negotiate away from the FCC-imposed interference rules—rules that themselves are likely to be less protective in a licensed environment. By contrast, in an unlicensed regime, there would be no mechanism for white-space users to pay broadcasters to accept additional interference. This is the single most important short-run difference between a licensed and an unlicensed regime for the TV band.

Unlicensed advocates claim that the FCC provides such a mechanism in its role as a regulator. The problem with FCC as interference-tradeoff-facilitator is that it cannot take money from winners to compensate losers; thus it continually blocks or foregoes efficiency-enhancing moves because potential losers object. In addition, the FCC often lacks a clear view of the size of the potential gains and losses. That is a weakness of any non-market institution; compounding it here is the tendency for government entities to assess benefits and costs using political as well as economic criteria.

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[60] John R. Williams, "Private Frequency Coordination in the Common-Carrier Point-to-Point Microwave Service," FCC OPP Working Paper Series, Number 21 (September 1986).

Better Incentives for Investment: In addition to encouraging more extensive use of the white space, licensed access would create better incentives for investment in long-range wireless telecommunications infrastructure. A service provider operating in the white space must have one or more access points in order to offer efficient long-range and rural service. Because any single access point represents a significant portion of the service provider's network, interference to such an access point threatens the provider's investment as well as its brand reputation. Service providers investing in long-range systems have a strong preference for licensed spectrum over unlicensed spectrum, because it allows them to avoid that threat.[61]

More generally, wireless service providers operating in licensed spectrum have greater control over service quality. A key issue is service reliability. People want voice calls everywhere, all the time. Similarly, they do not want music or TV programs to go on and off as they walk around listening to and watching their mobile wireless devices. Licensed spectrum, unlike unlicensed spectrum, can support those wireless applications that require reasonably reliable radio links and/or extensive coverage.

In contrast, as we discussed earlier, the incentives to invest in service-provider infrastructure, particularly long-range infrastructure, is substantially weaker in unlicensed spectrum than in licensed spectrum. To the extent that one wishes to see the white space provide an additional path connecting homes and businesses to the Internet, a licensed regime is likely to result in far more investment and service than an unlicensed regime.

2. Facilitates Long-Run Transition of TV Band

In addition to these short-run benefits, a major benefit of licensed operation will come in the long run: licensed operation in the white space will facilitate evolution away from the use of the UHF spectrum for TV. If broadcasters were given flexible use rights to the spectrum implicitly defined by their licenses, those rights could be combined with the white-space overlay rights to provide a variety of services. Over a decade or so, broadcasters and overlay licensees could reengineer the broadcast system, freeing up most of the broadcast station's spectrum for higher value uses while maintaining a core of over-the-air broadcast service. Ultimately, the overlay license or licenses and the broadcaster licenses could merge into a license structured much like today's PCS licenses.

This kind of evolution is not just theory. The FCC auctioned off overlay licenses in the MDS service (now called BRS), SMRS, and paging, so as to facilitate such a transition. See, for example, FCC auction 6 (MDS, 1995), auction 16 (SMRS, 1997), and auction 48 (paging, 2003). (By contrast, the MVDS license auction squeezed in a new operator, but in a way that moved

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[61] Short-range systems, such as 802.11 hotspots face somewhat different incentives with respect to interference. Perhaps most important, the economics of coverage expansion are quite different. If interference knocks out 802.11 coverage in one corner of a Starbucks coffee shop, for a few hundred dollars, Starbucks can put another 802.11 access point in the ceiling and run the necessary Cat 5 wiring back to the network hub. No such low-cost remedy is possible if interference destroys reception at a base station serving hundreds of subscribers.

farther away from a property rights regime in the DBS band.) The FCC fact sheet for auction 48 describes how the new license relates to the incumbent licenses:

> Incumbent (non-geographic) paging licensees operating under their existing authorizations are entitled to full protection from co-channel interference. Geographic area licensees are likewise afforded co-channel interference protection from incumbent licensees. Adjacent geographic area licensees are obligated to resolve possible interference concerns of adjacent geographic area licensees by negotiating a mutually acceptable agreement with the neighboring geographic licensee.

In the case of PCS, licenses were auctioned off but PCS licensees had to protect the incumbent public-safety microwave systems for a number of years. If a PCS operator wanted those microwave systems to leave early, the PCS operator had to persuade (*i.e.*, pay) the microwave operator to do so. The approach worked, and microwave operations were cleared off the PCS band with little difficulty.

A major impediment to the use of a similar, transitional approach in the TV band is the political opposition—much of it from unlicensed advocates—to having broadcasters receive a windfall in the form of flexible use rights.[62] However, giving broadcasters a windfall is preferable to having them tie up the TV spectrum indefinitely. Professor Hazlett compares the broadcasters to the mule that blocked Gen. Patton's convoy in World War II, and concludes that, "[d]istasteful though it is, the efficient solution is not to shoot the mule but to bribe it to saunter along."[63] Among other benefits, the competition made possible by the "bribe" would limit the size of the windfall, as Hazlett explains:

> Rather than blocking new technologies, broadcast stations would seek out more efficient video distribution platforms, capturing part of the social gains created….The outcome would be that networks would compete to offer current services at much lower prices, and jockey to introduce an array of innovative applications. This is the pro-consumer way to reform, and it is the one way to curb windfalls without punishing consumers with the collateral damage of delay and inefficiency.[64]

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[62] Neuchterlein and Weiser write that much of the reluctance to adopt more market-oriented spectrum reform stems from political objection to having licensees that didn't pay for their spectrum receive a windfall. As one flaw in that objection, they note that the public's claim to compensation for spectrum is weak. "Policymakers …sometimes forget that auctions are properly justified not as mechanisms for compensating the public for the use of "its" airwaves, but as a means of assigning spectrum rights as quickly as possible to those who would make the most efficient use of them." Neuchterlein and Weiser, *op. cit.*, pp. 245-246.

[63] "Hostage Standoff," *The Political Spectrum* (March 19, 2001).

[64] Testimony of Thomas W. Hazlett, Senate Committee on Science, Commerce and Transportation, Hearing on the Digital Television Transition (June 9, 2004).

C. Is it Really Feasible to License the White Space?

A key (perhaps *the* key) question about a licensed approach to the white space is its practical and commercial feasibility. Unlicensed advocates, in particular, maintain that the administrative and coordination costs of a licensed regime would swamp the benefits. Others, including FCC officials, have raised legitimate questions about how a licensed approach would accommodate wireless microphones and new broadcast licensees. It is essential to address the feasibility issue.

As a starting point, note that the TV white space offers several advantages as an environment for licensed operations. First, the primary systems to be protected—broadcast stations and land mobile operations—are well defined. Consequently, it should be reasonably easy for a licensee to protect these systems from interference. Second, the noise level in most of the white space is quite low, which would facilitate long-range operations.

Further evidence that licensing would work comes from those systems that have successfully used the TV white space on that basis for decades. A prominent example is land mobile radio, which has operated on channels 14-20 in several major metropolitan areas since the 1970s. Granted, land mobile systems rely on a relatively simple spectrum-sharing technique (pure geographic separation), whereas licensed systems for the TV white space would require more complex techniques (*e.g.*, close-in engineering of base stations using directional antennas, frequency coordination and interference negotiation). Nevertheless, the longstanding operation of land mobile services demonstrates the basic feasibility of a licensed approach in the TV band.

Transaction Costs

"Swiss Cheese": To the limited extent that they have acknowledged the licensed alternative, unlicensed advocates have tended to dismiss it on the grounds that the transaction costs would be prohibitive, as we discussed briefly in Section IV. According to this argument, the "Swiss cheese" character of the white space, combined with limits on the amount of white space in certain areas and the prospect of multiple white-space licensees, would make it extremely difficult to achieve the basic conditions for a market in white-space spectrum rights.[65]

One condition for such a market is reasonably well-defined property rights. Defining property rights in spectrum can be difficult because the rights are based on notions like avoiding harmful interference, which themselves can be hard to specify. Unlicensed advocates argue that it would be particularly tricky to define spectrum rights in the white space because the operating parameters would differ from market to market. For example, a channel that was available in Baltimore might not be available in nearby Washington, DC.

Although private parties can be expected to reach agreement on interference rights under a market-based approach, the patchwork nature of white space would make such negotiations prohibitively complex, according to unlicensed advocates. For example, a white-space licensee might have broadcasters A and B as neighbors to its channel N in one place, and broadcasters C

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[65] de Vries, *op. cit.*, pp. 14-15.

and D next to its channel N someplace else. Conversely, with multiple white-space licenses, broadcaster A could be dealing with licensee X in some places and licensee Y in others. By this argument, the sheer number of parties (and potential ambiguity as to their identity) would also make it difficult to negotiate variations from FCC interference standards—a major advantage claimed for the licensed approach.

An assessment of these arguments should start with a simple point that often gets overlooked: transaction costs are an issue only because licensed operations would make more extensive and efficient use of the white space than unlicensed operations. A white-space licensee could always eliminate (or significantly reduce) transaction costs by using the white space in the same way that unlicensed advocates propose—namely, with low-power devices and rule-based sharing protocols. Consumers would be no worse off under that scenario than under an unlicensed scenario; in fact, they would probably be better off because broadcasters might well tolerate less protective FCC interference standards in a licensed regime, as we discussed earlier. In sum, the issue of transaction costs arises only if licensed usages of the white space create spectrum opportunities that would not exist in an unlicensed regime.

Second, the transaction-costs argument is based on an assumption that white-space licenses will be carved up geographically. If the FCC were to auction off one or more nationwide licenses, the transaction costs related to negotiation among white-space licensees would be internalized.

Unlicensed advocates acknowledge this point but respond that the prospect of nationwide licenses is unrealistic: in their view, the FCC would have no choice but to divide white-space license assignments geographically in order to meet the needs of rural political interests. That may or may not be right. But even if licenses were assigned regionally, rather than nationally, the coordination problem among white-space licensees should be manageable.

To elaborate, the FCC has granted many regional overlay licenses, and it has almost always been able to minimize coordination costs. First, the Commission defines regions large enough that relatively little of the geographic area falls within coordination distance of the border (*e.g.*, Alaska might be a single licensing area). Second, the geographic boundaries are drawn so as to fall in less dense areas (*e.g.*, a boundary might run between New York City and Philadelphia but it would not run down the middle of 5th Avenue). Third, the Commission uses a variety of mechanisms to define harmful interference in a relatively unambiguous fashion.[66]

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[66] In some cases, it has used simple geographic separation rules (*e.g.*, a requirement that "transmit stations of the overlay licensee must be separated by more than 50 miles from base stations of the incumbent license"). In other cases, the Commission has used engineering rules to define harmful interference. These rules include the prohibition of the overlap of the 37 dBμ contours or adherence to the interference criteria set out in publications such as EIA TSB 10E, TIA TSB 88B, or OET-69. Typically such rules are based on a mathematical model that estimates the magnitude of a potentially interfering signal and determines whether it amounts to harmful interference, based on a description of the transmitting equipment, protected receivers, relevant antennas, and surrounding terrain. Such mathematical models are relatively low cost and reasonably accurate, and the results are more reproducible than actual measurements. Consequently, they provide an excellent basis on which to set the starting point for Coasian bargaining over interference adjustments.

In sum, with well-drawn regional licenses, coordination among white-space licensees should not be a significant burden. Coordination between licensees and broadcasters is a more challenging problem, but that too is manageable because any single negotiation—*i.e.*, the negotiation associated with a single base station or a single small geographic region—would have only a limited number of parties. Many negotiations would have only two participating parties (the service provider and the co-channel broadcaster). A smaller number of negotiations would require two additional parties (the broadcasters on the upper-adjacent and lower-adjacent channels).

As with geographic coverage, the transaction costs related to channel coverage would be internalized if the white space license(s) covered the entire area—in this case, all of the channels in the TV band. However, even if only a subset of those channels were covered, it would be possible to draw the boundaries of the license in a way that eliminated or substantially reduced adjacent channels issues between white space licensees. The key is the naturally occurring gaps in the TV band: channels 13 and 14 are not adjacent, and channel 37 is reserved for radio astronomy. If the licenses conformed to those gaps—with one license covering channels 2-13, another covering channels 14-36 and a third covering 38-51—there would be no first-adjacent channel issues among white space licensees.

Rural Spectrum Access: Unlicensed advocates also point to transaction costs as the basis for their claim that rural areas would not benefit from licensed access to the white space. According to this argument, a large telecommunications firm that held white-pace licenses covering rural areas might be unwilling to lease or sell spectrum access to a start-up WISP because the transaction costs would swamp the benefits to the license-holder.

Rural service providers appear to have a strong preference for licensed spectrum.[67] Moreover, rural spectrum is relatively inexpensive. Thus, if WISPs cannot get affordable access to licensed spectrum, transaction costs may be part of the reason. The FCC's rules for spectrum leasing may be one source of that impediment. Rural service providers' lack of experience with those rules may be another.

However, transaction costs probably are not the major impediment to ubiquitous rural broadband. Rather, the cost of providing service to many underserved areas is itself too high—that is, it is not economic for commercial providers even at the cheap price of rural spectrum. Insofar as underserved areas are not viable markets, lower transaction costs in the form of unlicensed white space will not help.

Moreover, even if transaction costs are a serious impediment to rural service, a licensed approach to the white space could help to address the problem. As we discussed earlier, the greater availability of white space in certain areas, many of them rural, will make it attractive for

[67] National Telecommunications Cooperative Association, "NTCA 2005 Wireless Survey Report" (January 2006). NTCA respondents indicated that they would prefer access to additional licensed spectrum over additional unlicensed spectrum by a margin of 73 percent to 27 percent.

licensees to serve as band managers or sublessors. Thus, the transaction costs may be lower for access to licensed white space than it has been for access to existing licensed spectrum.

In sum, it is easy for advocates for potential service providers to say that the impediment to rural broadband is spectrum availability (*i.e.*, high transaction costs). But insofar as the real problem is the lack of adequate economic return, as we believe it is, unlicensed white space will not provide a solution.

Wireless Microphones

The TV white space is home to thousands of wireless microphones, which are used in TV studios, at sports events and for electronic news gathering. Many wireless microphones are licensed, albeit on a secondary basis. However, a large number are used on an unlicensed basis—apparently in violation of FCC rules.

These licensed wireless microphones, many of them operated by broadcasters, represent clear evidence that operations in the white space are feasible. However, the need to protect wireless microphones from interference creates a challenge to an overlay licensee. Many of the users of these microphones have no reasonable alternative—at least in the short run. Moreover, these microphones use a relatively simple radio link (standard analog FM) that is less efficient in its use of radio spectrum and less tolerant of interference than more modern counterparts.

Wireless microphones change location over periods of time measured in hours or days, not months or years, as is the case with TV stations. Consequently, interference-avoidance mechanisms using a static or slowly-changing geographic database will not be able to protect these devices. Various mechanisms (*e.g.*, alerting beacons) have been proposed to permit unlicensed devices to detect and avoid interfering with wireless microphones.

Michael Marcus and two co-authors propose that wireless microphones ultimately be replaced with other technology.[68] Although such replacement could be part of a long-run plan for efficient use of the TV spectrum, there is a good case for protecting the current investment in wireless microphones during the transition. The operators of licensed wireless microphones themselves have made a significant investment, based on current FCC rules, as have those businesses that ultimately depend on the wireless microphones. Thus, any approach to the white space should handle licensed wireless microphones in a way that is fair as well as efficient.

Several transition policies are possible. One would be to move the wireless microphone users into a subset of all white-space channels.[69] By limiting wireless microphones to a fraction of each TV channel, this approach would accommodate their continued operation while making most of the spectrum available for use by the white-space licensee. Another approach would be to require individual white-space licensees to protect wireless microphones for a period of 5

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68 Michael J. Marcus, Paul Kolodzy and Andrew Lippman, "Why Unlicensed Use of Vacant TV Spectrum Will Not Interfere With Television Reception," New America Foundation, Issue Brief # 19 (July 2006), p. 8.

69 Marcus *et al*. also suggest this alternative.

years—for example, by setting aside a fraction of their licensed bandwidth for the wireless microphones to use on a coordinated basis. Licensees that used OFDM or a similar technology could provide substantial interference protection to wireless microphones by transmitting zero power on those OFDM carriers that would otherwise interfere with nearby microphones. In sum, reasonable coordination policies, together with the appropriate technologies, could protect wireless microphones, albeit at some cost to the capacity and/or efficiency of the licensed system.

It is important to note that wireless microphones will be an issue for unlicensed as well as licensed operations in the white space. However, in a licensed regime, the parties will be able to negotiate and make side-payments. An unlicensed regime, by contrast, would preclude those efficiency-enhancing agreements.

New TV Licenses

As phrased here, the white-space licensee would have exclusive use of the white space. It would no longer be possible to grant new TV broadcast licenses or translator licenses. Given the nature of land-mobile technologies—the fact that land mobile service in an urban area is provided by hundreds of licensees operating transmitters using 25 kHz and 12.5 kHz slivers of spectrum, providing protection to land-mobile operations is probably best accomplished by protecting an entire TV channel in any urban area in which that channel is used for land mobile.

Of course, the FCC could adopt other rules—such as permitting the continued licensing of TV stations. Doing so would create uncertainty that would decrease the value of the white space and probably decrease auction revenues. Moreover, people have had more than half a century to apply for TV licenses and two decades to apply for LPTV licenses; thus there are not many good license opportunities still vacant. Consequently, shutting down TV licensing would have little impact on the availability of TV service to consumers. And, of course, those wishing to offer a new TV service could negotiate rights to do so from the white-space license holder.

D. Estimated Auction Value of the White Space

Under a licensed approach, the FCC could auction the exclusive, tradable rights to use of the white space just as it has auctioned other spectrum rights. Using calculations of the amount of white space, as summarized in Section III and Appendix A, we estimate the auction value of those rights. Under our most conservative licensed scenario, we find that the rights to the white space would generate an estimated \$3.6 billion to \$6 billion. Although policymakers should not focus excessively on the size of potential auction revenues, neither should they ignore them.

Starting Point for a Valuation of the White Space

Demand: Demand for licensed spectrum that can support wireless service remains strong, as the FCC's recent AWS auction demonstrated. This trend is likely to continue. Spectrum and wireless base stations are substitutes: a capacity-limited wireless system can expand by using more spectrum at existing cell sites or by building additional cell sites; the former is considerably less expensive than the latter, even at current spectrum prices. Thus, as long as they continue to attract subscribers and generate increased usage, such systems will demand additional spectrum.

Demand for the white space should be solid for the same reason. As we have discussed, that portion of the white space that is nationwide in scope could potentially support broadband PCS, including fixed and mobile voice and data. More generally, the white space could be used to provide wireless broadband service, both fixed and mobile. The UHF white space (500 MHz to 700 MHz) is particularly well suited for providing wireless services over relatively long distances, which would allow a network to be deployed using far fewer cell sites than would be required at higher frequencies.

Quantity: In Section III, we concluded that there will be a critical mass of white space in the TV core under any of our licensed scenarios. Recall the key statistics on our most conservative licensed scenario (Scenario Z):

- 95 percent of the U.S. population will be covered by at least 24 MHz of white space;
- Every market trading area (MTA) except one (San Francisco-Oakland-San Jose) will have at least two channels (12 MHz) of white space available everywhere in the MTA;
- More than 90 percent of basic trading areas (BTAs) will have at least two channels (12 MHz) that are entirely vacant (100 percent white space) everywhere in the BTA.

Caveat: It is more difficult, analytically, to estimate how the market would value the white space (price) than to estimate how much white space there is (quantity). Key variables that would affect price remain uncertain, including how the FCC would structure the licenses and the exact services that licensees would offer. Another unknown factor—the FCC's interference protection rules—could affect the unit price of white space as well as the quantity. Given these major sources of uncertainty, our goal is to provide only a "ballpark" estimate of the value of the white space, and in doing that, we try to avoid conveying any false sense of precision.

Market Comparable Approach

We use a market comparable (or market) approach to valuing the rights to the white space. This approach, which has its roots in real estate, uses the prices paid for equivalent licenses in the market as the basis for the valuation.[70]

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[70] The other valuation technique that economists frequently use is the income approach. This approach is based on the assumption that the value of a spectrum license is equal to the expected future benefits (income) to the license holder discounted at a rate that reflects the time value of money and the risk involved. The income and the market comparable approach should yield similar results because the prices paid for comparable licenses reflect the present value of the future income stream that ownership of the license being valued would provide.

Base Case: We use the 2.5 GHz BRS/EBS band as the market comparable under our "base case" estimate of the value of white space. The 2.5 GHz BRS/EBS band is a reasonable comparable for two reasons. First, the 2.5 GHz band is not systematically paired. Second, 2.5 GHz face impediments to operation as a result of the need to either accommodate or transition site-specific incumbent licensees.[71] These factors have contributed significantly to the fact that 2.5 GHz license values are below what they would otherwise be, given the prime location of the spectrum. In recent secondary transactions, 2.5 GHz licenses have sold for $0.15 to $0.20 per MHz-pop; that is only a third of what AWS licenses commanded, on average, in the recent FCC auction, and only about 10 percent of the price of PCS licenses.

We use the low end of the price range for 2.5 GHz EBS/BRS licenses ($0.15) as the basis for our "base case" Scenario Z estimate.

High-End Case: The 2.5 GHz band may be a conservative measure of the value of at least some of the white space—specifically, the 24 MHz of nationwide spectrum, which could be used to support a PCS operation. Thus, under our "high-end" case, we use the AWS spectrum as a comparable for the nationwide white space (for the rest of the white space, we continue to use the 2.5 GHz band).

The AWS spectrum sold for $0.54 per MHz-pop; we use $0.50 as the basis for valuing the 24 MHz of nationwide white space under our "high-end" version of Scenario Z.

Valuation Estimate

Table 5 shows our "base case" and "high-end" estimates for the value of the spectrum rights to the white space under Scenario Z.

Using the price of 2.5 GHz licenses ($0.15) as the basis for valuing all of the white space ("base case"), we estimate that exclusive, tradable rights to the white space could be worth as much as $3.7 billion.[72] That may seem like a "big" number, particularly given the relatively low per MHz-pop value we have assigned to the white space; the reason: the sheer quantity of white space is large, even under our most conservative licensed scenario.

Under our "high-end" version of Scenario Z, in which we use $0.50 to value the choicest part of the white space, we estimate that the total value could be as high as $6 billion.

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[71] Granted, other factors might lead one to adjust 2.5 GHz prices upward or downward as an estimate of the value of white space, but in our view, these factors balance out. For example, the 2.5 GHz band has large contiguous blocks of spectrum, which would be more attractive than the white space, with its patchwork quality in key metropolitan markets. But the propagation characteristics of the white space are far superior to those of the 2.5 band, which would allow for a significant savings in the capital expenditure for basic coverage.

[72] We also used our "base-case" assumption to calculate the value of the white space under the other scenarios. Those figures range from a high of $7.8 billion (Scenario X) to a low of $2.0 billion (Scenario U-2).

Table 5

Estimated Value of White Space -- Scenario Z

Metric	"Base Case" Estimate	"High End" Estimate [2]
Total MHz-Pops in TV White Space (Billions)	27.2	20.6
Total MHz-Pops in 24 MHz National License (Billions)	N/A	6.6
Total MHz-Pops (Billions)	27.2	27.2
Value of Spectrum at $0.15 per MHz-Pop ($ Billions) [1]	$3.7	$2.7
Value of Spectrum at $0.50 per MHz-Pop ($ Billions)	N/A	$3.3
Total Value ($ Billions)	$3.7	$6.0

[1] $0.15 represents the national average for 2.5 GHz BRS/EBS spectrum, which we use for our valuation of the white space. We use the relative BTA spectrum values from FCC Broadband PCS Auctions 5 and 11 to estimate the value corresponding to the $0.15 for each BTA and then aggregate nationwide. Because much of the white space is found in BTAs with below average relative license values (per the PCS auctions), the weighted average $/MHz-Pop for the white space overall is lower than $0.15 / MHz-Pop.
[2] Based on 1) license(s) for 24 MHz nationwide and 2) license(s) for the remainder white space. Only for the purpose of this calculation, we assume that the 24 MHz of nationwide spectrum would be licensed as different sets of four channels in each BTA. In cases where there were not four 100% vacant channels in a BTA, we selected the four channels that had the highest percentage of vacancy in terms of population.

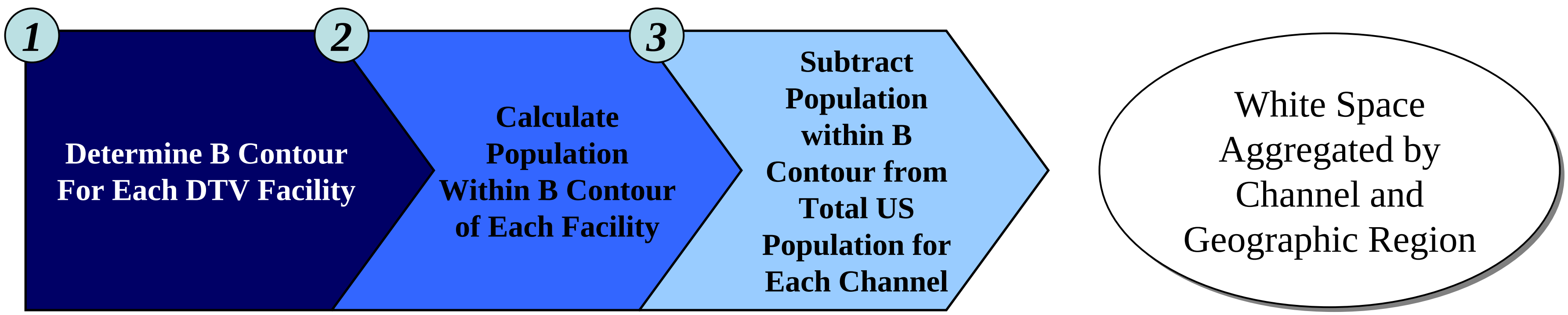
APPENDIX A

Calculation of White Space in the TV Core Following the DTV Transition

Appendix Contents

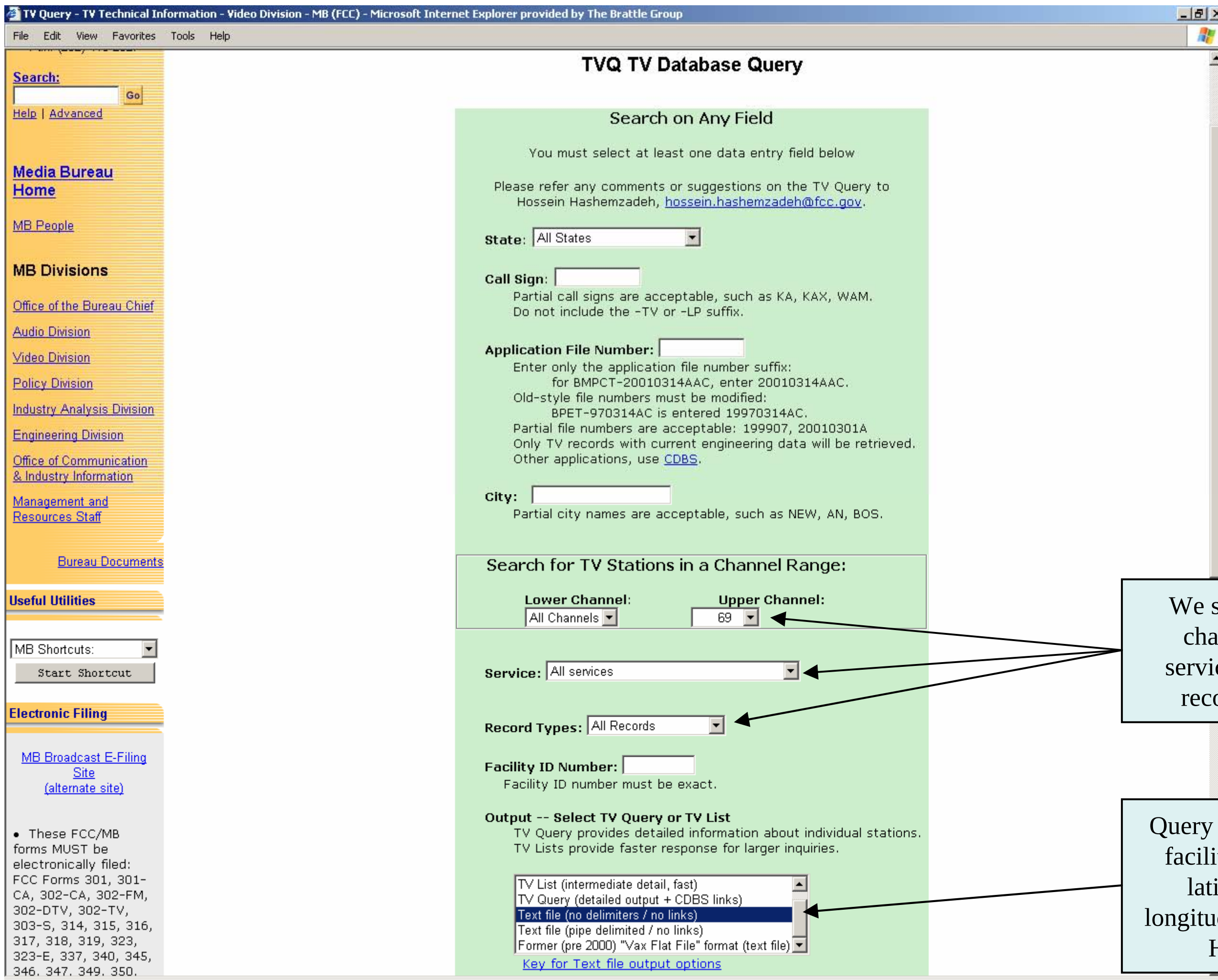
- Methodology
- Results
- General Observations

We were asked to calculate how much unused wireless spectrum ("white space") there will be in the TV core following the DTV transition. We took the approach outlined here.



We will discuss each of these steps in more detail in the following pages.

We downloaded TV facility data from the FCC's TV Query page (www.fcc.gov/fcc-bin/audio/tvq.html), which runs queries on the FCC Media Bureau's Consolidated Database System for TV, FM, and AM Stations or "CDBS".



We selected all channels, all services, and all record types.

Query output gives facility channel, latitude and longitude, ERP, and HAAT.

Source: FCC CDBS / TV Query, downloaded May 16, 2006

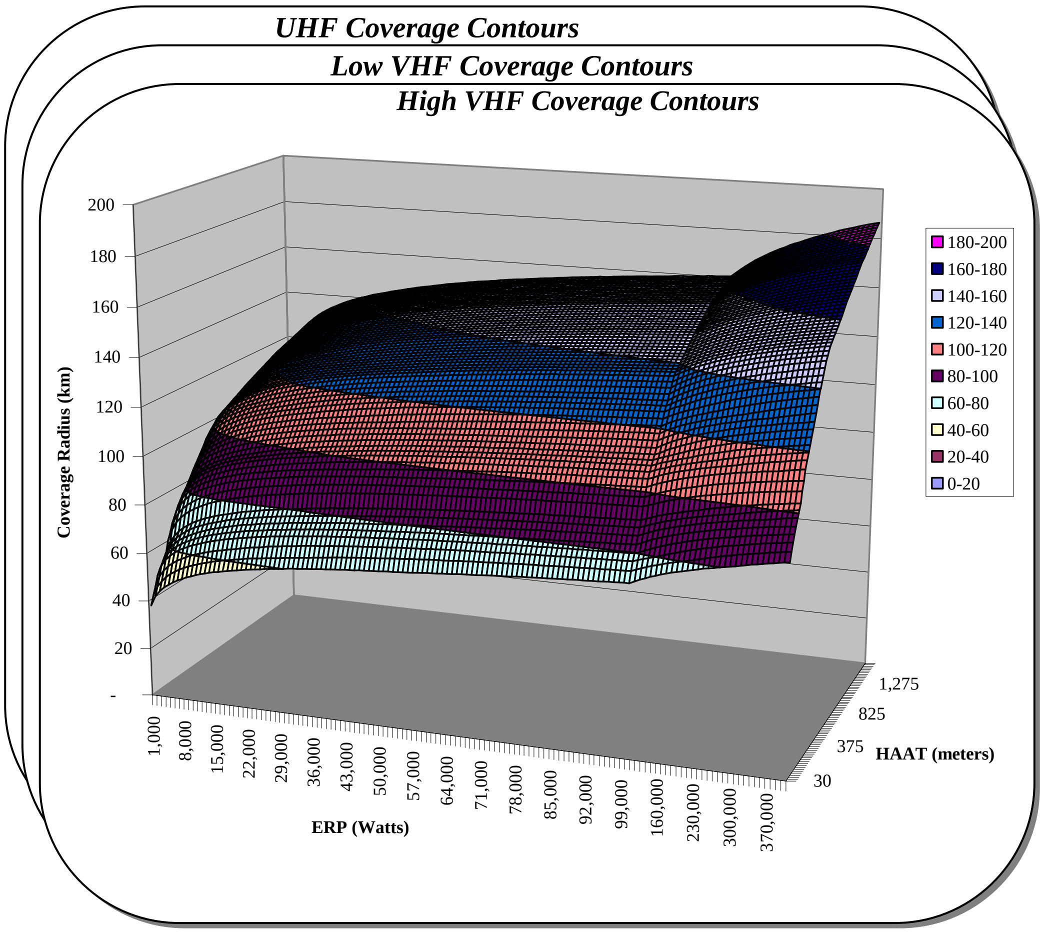
We incorporated more than 10,000 antennas into our analysis. This includes all of the 1,789 tentative digital channel designations for stations participating in the 1st and 2nd rounds of the DTV channel election process (per FCC, May 23, 2006).

Composition of Facilities Used in White Space Calculation

Facility Treatment Categories	*Facility Treatment Category Characteristics* Station Type	Channel Location	Records Included	*Total Facilities by Country* U.S.	Canada	Mexico	Total
Data Source Totals							
Total Records Considered from TV Query of CDBS				18,257	2,394	558	21,209
Total Unique Facility IDs				12,510	2,373	551	15,434
Included Unique Facility ID in White Space Calculation							
Digital TV Stations	DTV	Core	Lic. & Apps	1,618	840	148	2,606
Digital Low Power TV Stations	DTV	Core	Lic. & Apps	632	-	-	632
DTV Channel Substitution Records	DTV	Core	Lic. & Apps	174	4	-	178
Digital Class A TV Stations	DTV	Core	Lic. & Apps	37	-	-	37
New DTV Allotment Records	DTV	Core	Lic. & Apps	32	-	-	32
DTV Channel Change Records	DTV	Core	Lic. & Apps	27	-	-	27
Digital Special Temporary Authority Records	DTV	Core	Lic. & Apps	1	-	-	1
Non-core DTV Stations (assuming NTSC channel)	NTSC	Non-Core	Lic. & Apps	130	-	-	130
Core NTSC Licensed Stations (assuming NTSC channel)	NTSC	Core	Lic.	89	435	28	552
Subtotal - DTV Stations				2,740	1,279	176	4,195
Class A TV	NTSC	Core	Lic. & Apps	515	-	-	515
TV Translators (included in some scenarios)	NTSC	Core	Lic. & Apps	7,315	124	24	7,463
Subtotal - Other Protected NTSC Facilities				7,830	124	24	7,978
Total Included Facilities in White Space Calculation				10,570	1,403	200	12,173
Excluded Unique Facility ID from White Space Calculation							
Non-core DTV Facilities with no core application	DTV	Non-Core	Lic. & Apps	18	205	45	268
NTSC Allotments and Boosters	NTSC	Both	Lic. & Apps	348	659	285	1,292
Land Mobile Records in CDBS (using 47 CFR 90.305(a) instead)	NTSC	Core	Lic. & Apps	24	-	-	24
Core NTSC Applications	NTSC	Core	Apps	247	54	7	308
Non-core NTSC Channels with No DTV Application	NTSC	Non-Core	Lic. & Apps	89	38	2	129
Non-core Translators with No DTV Application	NTSC	Non-Core	Lic. & Apps	1,214	14	12	1,240
Total Excluded Facilities from White Space Calculation				1,940	970	351	3,261

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

We calculated the average coverage radius for each facility using contours for Low VHF, High VHF, and UHF.



Other Radius and Power Assumptions

- For those NTSC facilities which we included in our analysis, we assumed they would operate at 25% of their current power (ERP) after transitioning to DTV.
- For Mexican and Canadian DTV facilities with no power (ERP) available in the CDBS, we assumed they would each operate at 300 kWs.
- For each NTSC TV Translator, we assumed a 10 mile radius.
- We use the distance specified in 47 CFR 90.305(a) for land mobile protection (*i.e.*, 128 km and 48 km for channel 16 in New York)
- We also block out a 100 mile radius around land mobile operations on Long Island in channel 19.

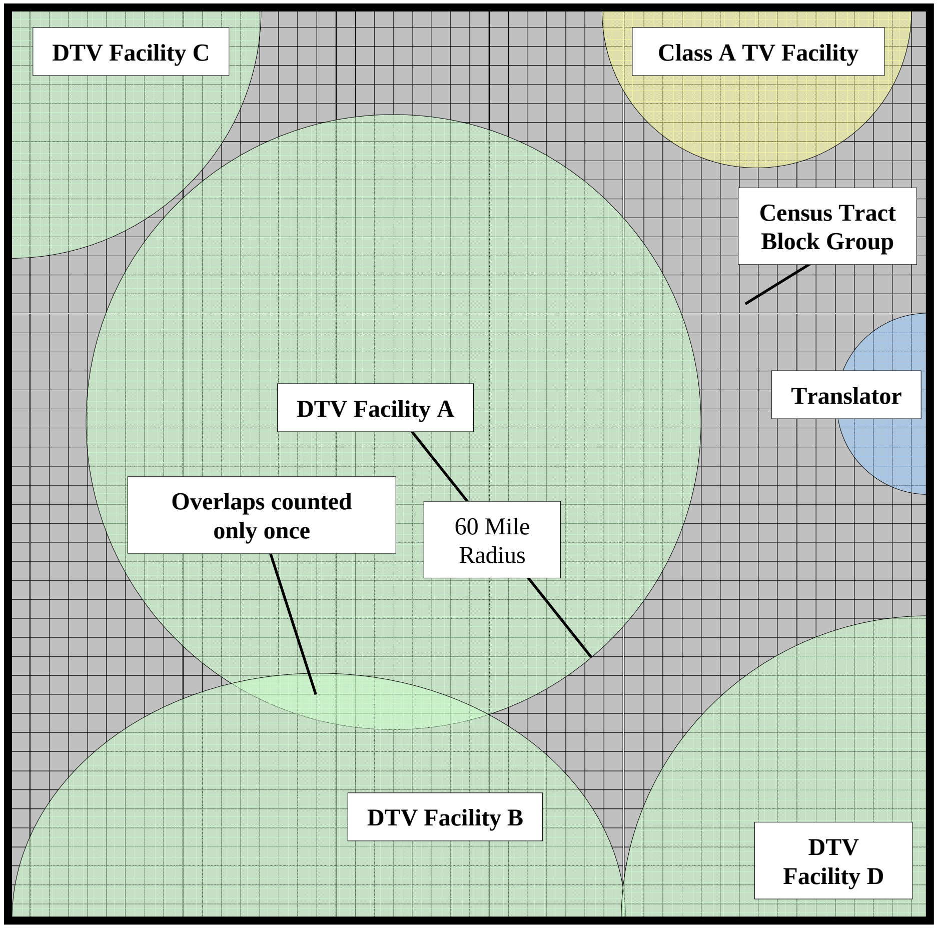
Source: Charles Jackson

We then calculated which Census tract block groups were within the coverage radius of each facility.

Population Coverage Methodology

- The US Census provides population data at the state, county, zip code, tract, and block group levels. The block group is the finest level of detail provided by the Census. There are more than 200,000 block groups each with an average population of about 1,300. The Census also provides a lat-long centroid for each block group.
- We developed a program to calculate the distance between each facility and each block group. If the distance is less than or equal to the coverage radius of that specific facility, we count the whole population within that block group as covered by that facility.
- We conduct this analysis on each channel separately. When we include adjacent channel protection, we treat each DTV facility as operating at three channels.

Illustrative DTV Facility & Census Tract Block Group Overlay for Specific Channel

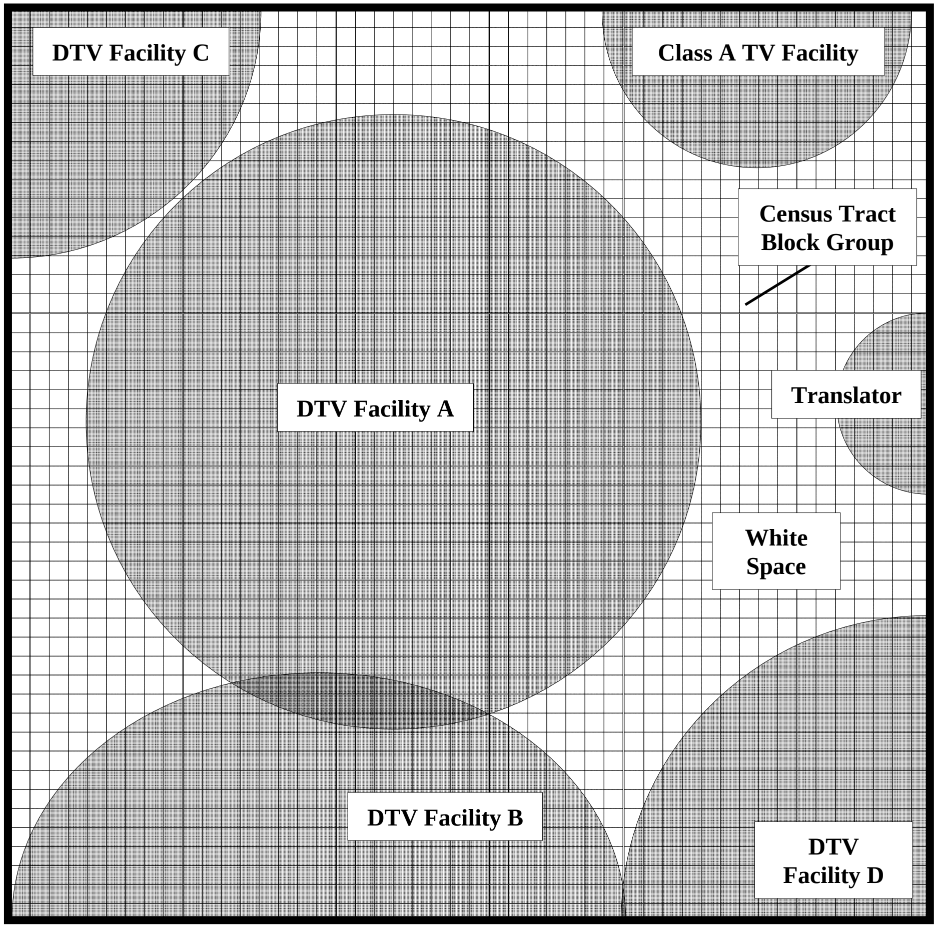


For each channel, we subtracted the population in the covered block groups from the total US population. The uncovered population represents the white space.

Population Subtraction Methodology

- For each channel, we consider any census tract block group not within the B contour of any DTV antenna as white space.
- For any geographic region, *e.g.*, an "MTA" (major trading area), the white space for any given channel is calculated as the total population in that MTA less the population within the B contour of any DTV antenna.
- We repeat this analysis for each channel.
- We aggregate our results by channel.

Illustrative TV Facility & Census Block Group Overlay for Specific Channel



In addition to presenting nationwide results, we show our results by individual MTA (major trading area).

MTA	2000 Census Population	Number of Block Groups	Average Population per Block Group
Alaska	626,932	533	1,176
Atlanta	8,731,699	5,135	1,700
Birmingham	3,555,114	2,697	1,318
Boston-Providence	10,009,759	7,996	1,252
Buffalo-Rochester	2,792,296	2,454	1,138
Charlotte-Greensboro-Greenville-Raleigh	11,613,265	7,801	1,489
Chicago	13,220,193	10,201	1,296
Cincinnati-Dayton	4,888,525	3,993	1,224
Cleveland	5,084,468	4,238	1,200
Columbus	2,392,826	1,933	1,238
Dallas-Fort Worth	11,688,918	8,892	1,315
Denver	4,907,635	3,801	1,291
Des Moines-Quad Cities	3,157,069	2,834	1,114
Detroit	10,658,459	9,076	1,174
El Paso-Albuquerque	2,533,752	1,851	1,369
Honolulu	1,211,537	646	1,875
Houston	6,307,777	3,977	1,586
Indianapolis	3,333,121	2,657	1,254
Jacksonville	2,740,381	1,737	1,578
Kansas City	3,202,863	2,716	1,179
Knoxville	1,944,407	1,427	1,363
Little Rock	2,385,905	1,850	1,290
Los Angeles-San Diego	22,223,875	14,178	1,567
Louisville-Lexington-Evansville	3,905,399	3,092	1,263
Memphis-Jackson	3,761,294	2,968	1,267
Miami-Fort Lauderdale	6,436,114	3,629	1,774
Milwaukee	4,941,046	4,053	1,219
Minneapolis-St. Paul	6,621,619	5,676	1,167
Nashville	2,165,007	1,393	1,554
New Orleans-Baton Rouge	5,399,308	3,938	1,371
New York	28,198,690	22,114	1,275
Oklahoma City	2,029,571	1,780	1,140
Omaha	1,794,352	1,685	1,065
Philadelphia	9,510,948	7,602	1,251
Phoenix	4,906,177	3,415	1,437
Pittsburgh	4,048,998	3,532	1,146
Portland	3,738,321	2,691	1,389
Puerto Rico-U.S. Virgin Islands	3,808,610	2,477	1,538
Richmond-Norfolk	4,238,094	3,017	1,405
Salt Lake City	3,319,967	2,266	1,465
San Antonio	3,716,676	2,474	1,502
San Francisco-Oakland-San Jose	13,782,432	9,279	1,485
Seattle	4,604,715	3,777	1,219
Spokane-Billings	2,178,445	1,976	1,102
St. Louis	5,018,297	4,097	1,225
Tampa-St. Petersburg-Orlando	6,660,705	3,772	1,766
Tulsa	1,224,694	963	1,272
Washington-Baltimore	8,799,742	5,904	1,490
Wichita	1,206,230	1,070	1,127

Alternative Presentation Methodologies

- Given that our results are at the block group level, we can present the amount of white space in a number of ways:
  - For the US as a whole
  - By county and state
  - By discrete area (*e.g.*, city or zip code)
  - By metropolitan area (*e.g.*, MSA and PMSA)
  - By typical FCC geographic license area (*e.g.*, BTA, CMA, MEA, EA, etc.)
  - By television market (*i.e.*, Nielsen DMA)

Source: 2000 US Census

Note: MTAs are geographic regions defined by Rand McNally and adopted by the FCC for wireless spectrum license areas. There are 51 MTAs in the US. We exclude 2 MTAs (Guam & N. Mariana Islands and American Samoa) from our analysis.

Appendix Contents

- Methodology
- Results
- General Observations

Below, we present the results of five different scenarios, corresponding to different assumptions as to FCC rules on interference.

Measures of White Space under Alternative Interference-Protection Scenarios

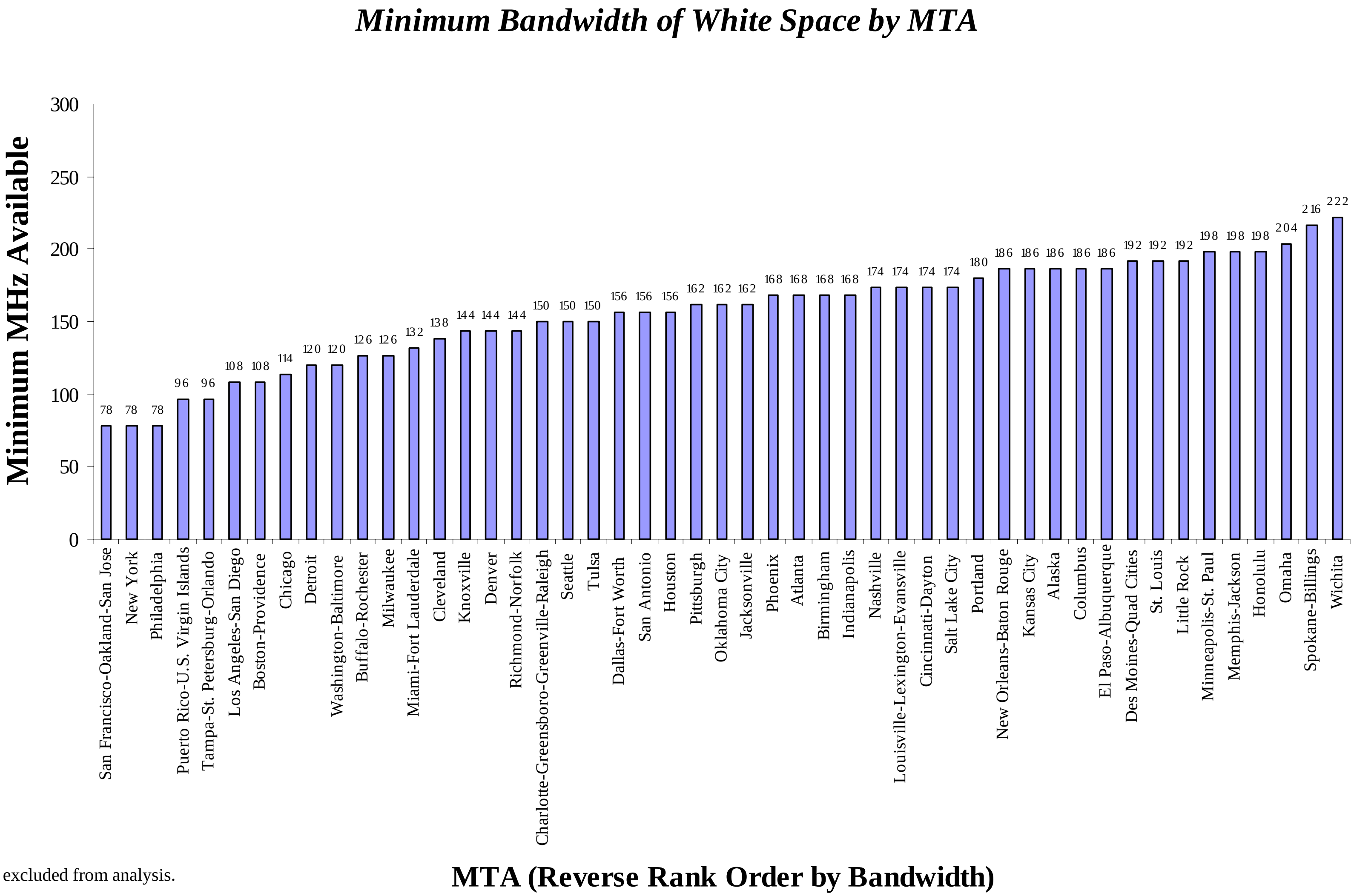
	Included Facilities	Co-Channel Protection	Adjacent-Channel Protection	*Total MHz-Pops in White Space (Millions)*			*Percent of MHz-Pops in White Space*			*White Space Bandwidth Covering 100% of Total Population*			*White Space Bandwidth Covering 95%+ of Total Population*			*Average White Space Bandwidth Available Nationwide*		
				2-51	5-51	14-51	2-51	5-51	14-51	2-51	5-51	14-51	2-51	5-51	14-51	2-51	5-51	14-51
Scenario X	All US, Canadian, and Mexican regular and Class A stations and land systems in the UHF TV spectrum.	FCC Radius	None	53,678	49,232	37,829	64%	63%	60%	78	60	36	108	90	60	188	173	133
Scenario Y	All US, Canadian, and Mexican regular and Class A stations and land systems in the UHF TV spectrum.	FCC Radius	FCC Radius	28,266	24,532	17,379	34%	31%	27%	0	0	0	24	12	6	99	86	61
Scenario Z	All US, Canadian, and Mexican regular and Class A stations, land systems in the UHF TV spectrum, and all TV translators.	FCC Radius	FCC Radius	27,156	23,523	16,547	32%	30%	26%	0	0	0	24	12	6	95	82	58
Scenario UL-1	All US, Canadian, and Mexican regular and Class A stations and land systems in the UHF TV spectrum.	FCC Radius plus 46, 30, and 17 miles for low VHF, high VHF, and UHF	FCC Radius plus 5 miles	21,028	18,093	12,752	25%	23%	20%	0	0	0	12	6	0	74	63	45
Scenario UL-2	All US, Canadian, and Mexican regular and Class A stations and land systems in the UHF TV spectrum. Channels 2-4 and 14-20 excluded.	FCC Radius plus 46, 30, and 17 miles for low VHF, high VHF, and UHF	FCC Radius plus 5 miles	15,160	15,160	9,820	18%	19%	16%	0	0	0	0	0	0	53	53	34

Note: Channel 37 excluded from analysis.

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

For Scenario X, we estimate there will be at least 78 MHz of white space nationwide.

Scenario X
Scenario Y
Scenario Z
Scenario UL-1
Scenario UL-2



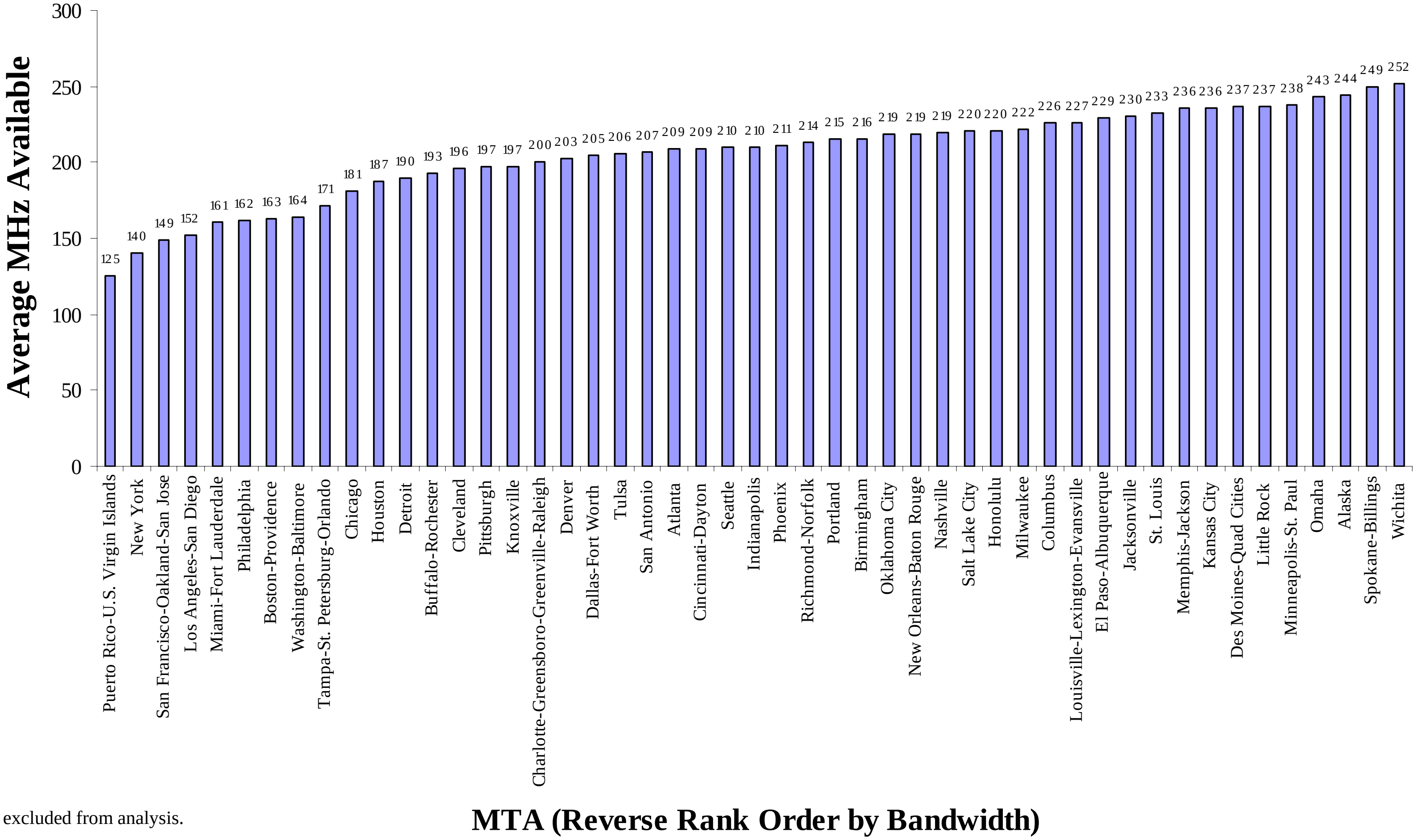
Note: Channel 37 excluded from analysis.

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

We estimate there will be an average of 188 MHz of white space, with about 150 MHz in the most concentrated MTAs.

Scenario X
Scenario Y
Scenario Z
Scenario UL-1
Scenario UL-2

Average Bandwidth of White Space by MTA



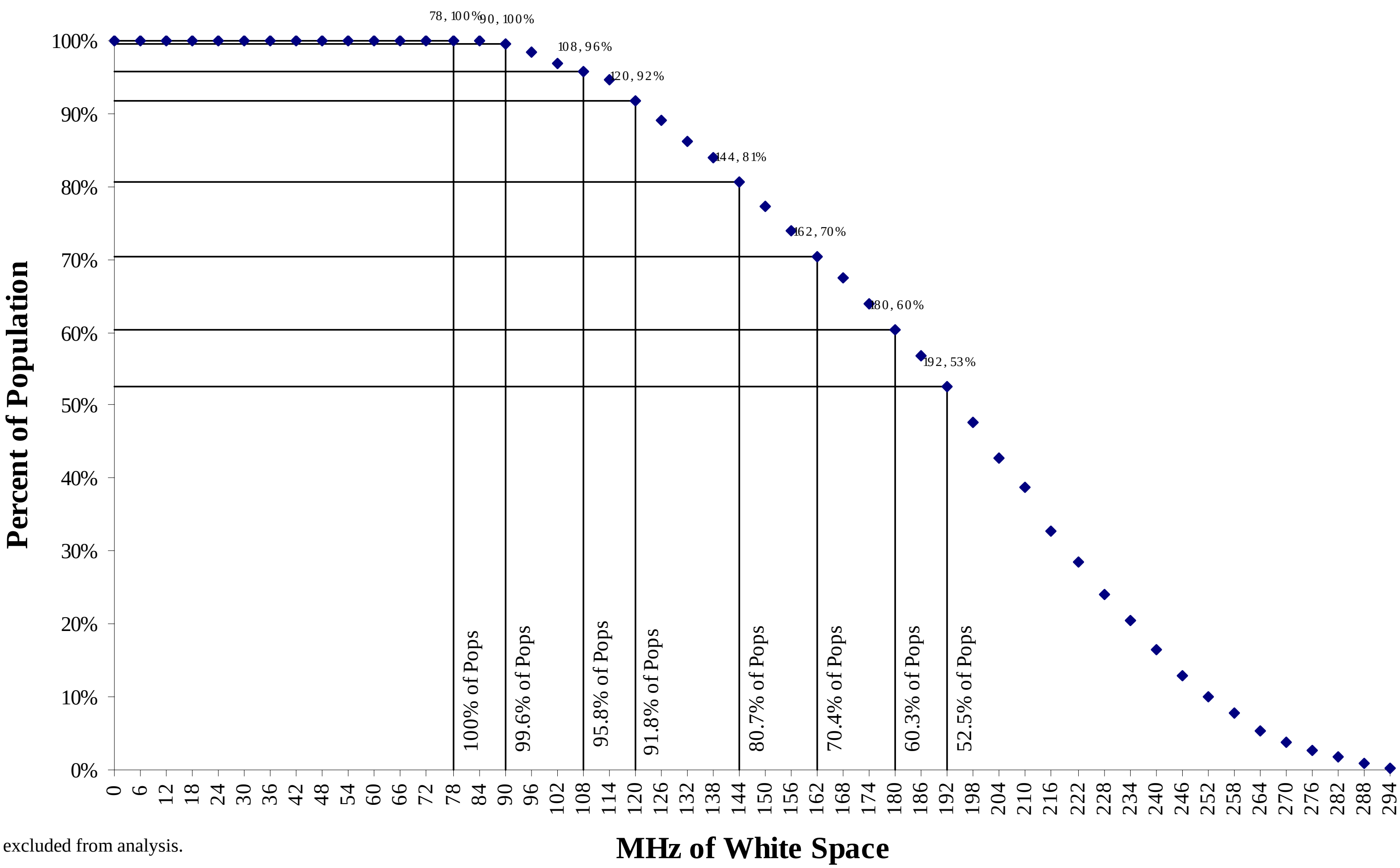
Note: Channel 37 excluded from analysis.

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

For channels 2-51, we estimate that 108 MHz of white space will be available to 95% of the US population.

Percent of Population with a Given Amount of White Space

Scenario X
Scenario Y
Scenario Z
Scenario UL-1
Scenario UL-2



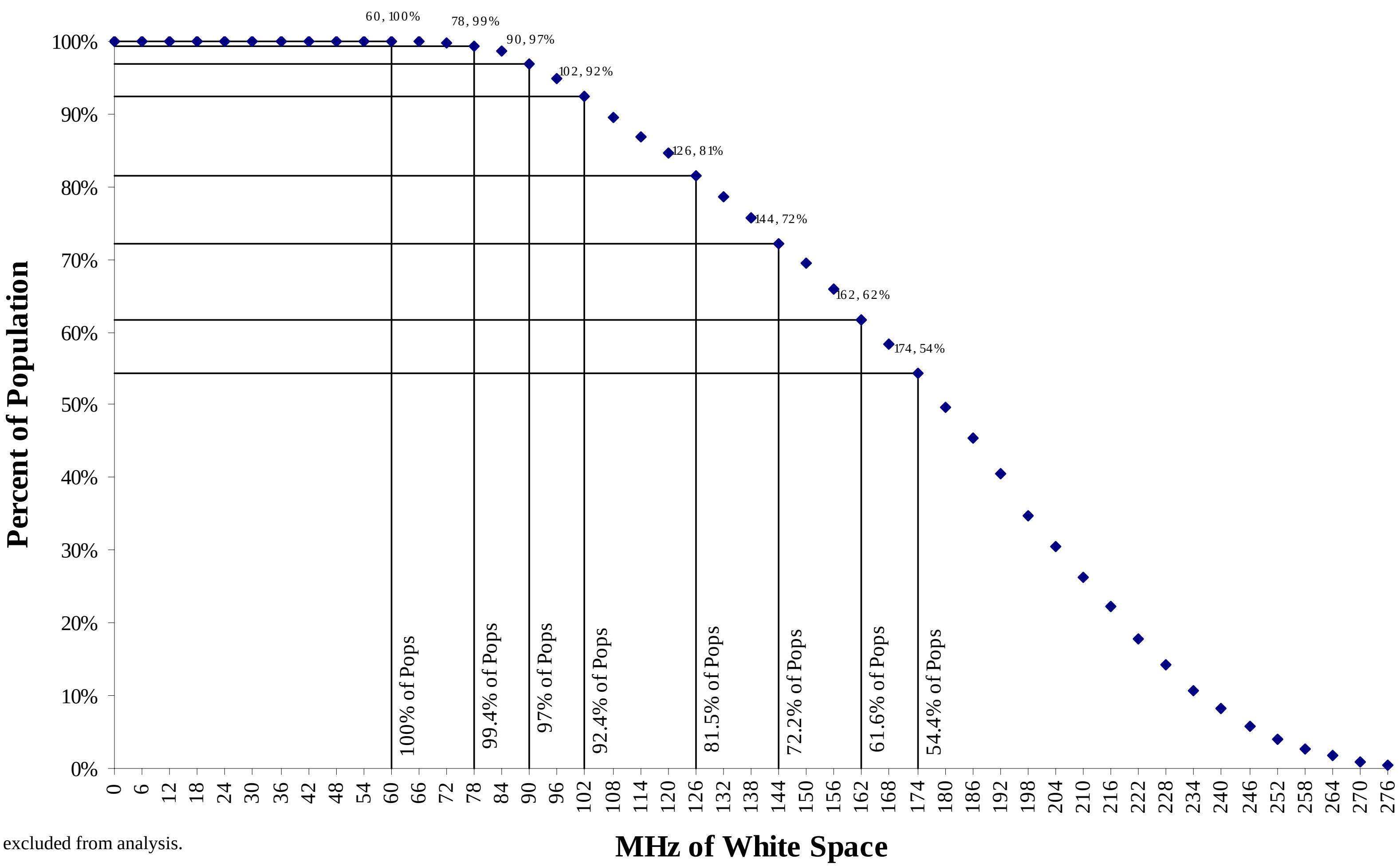
Note: Channel 37 excluded from analysis.

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

For channels 5-51, we estimate that 90 MHz of white space will be available to 95% of the US population.

Scenario X
Scenario Y
Scenario Z
Scenario UL-1
Scenario UL-2

Percent of Population with a Given Amount of White Space



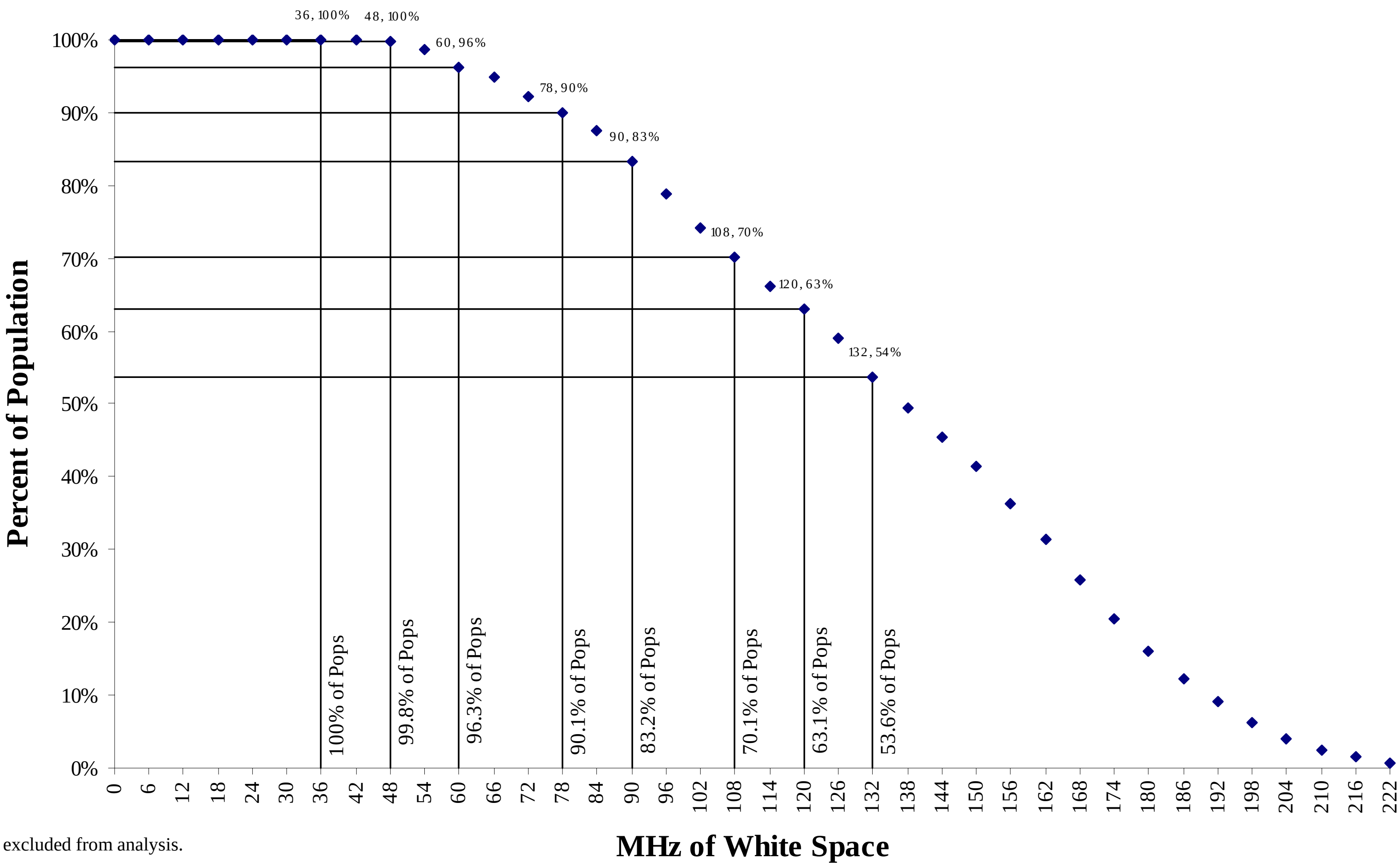
Note: Channel 37 excluded from analysis.

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

For channels 14-51, we estimate that 60 MHz of white space will be available to 95% of the US population.

Scenario X
Scenario Y
Scenario Z
Scenario UL-1
Scenario UL-2

Percent of Population with a Given Amount of White Space



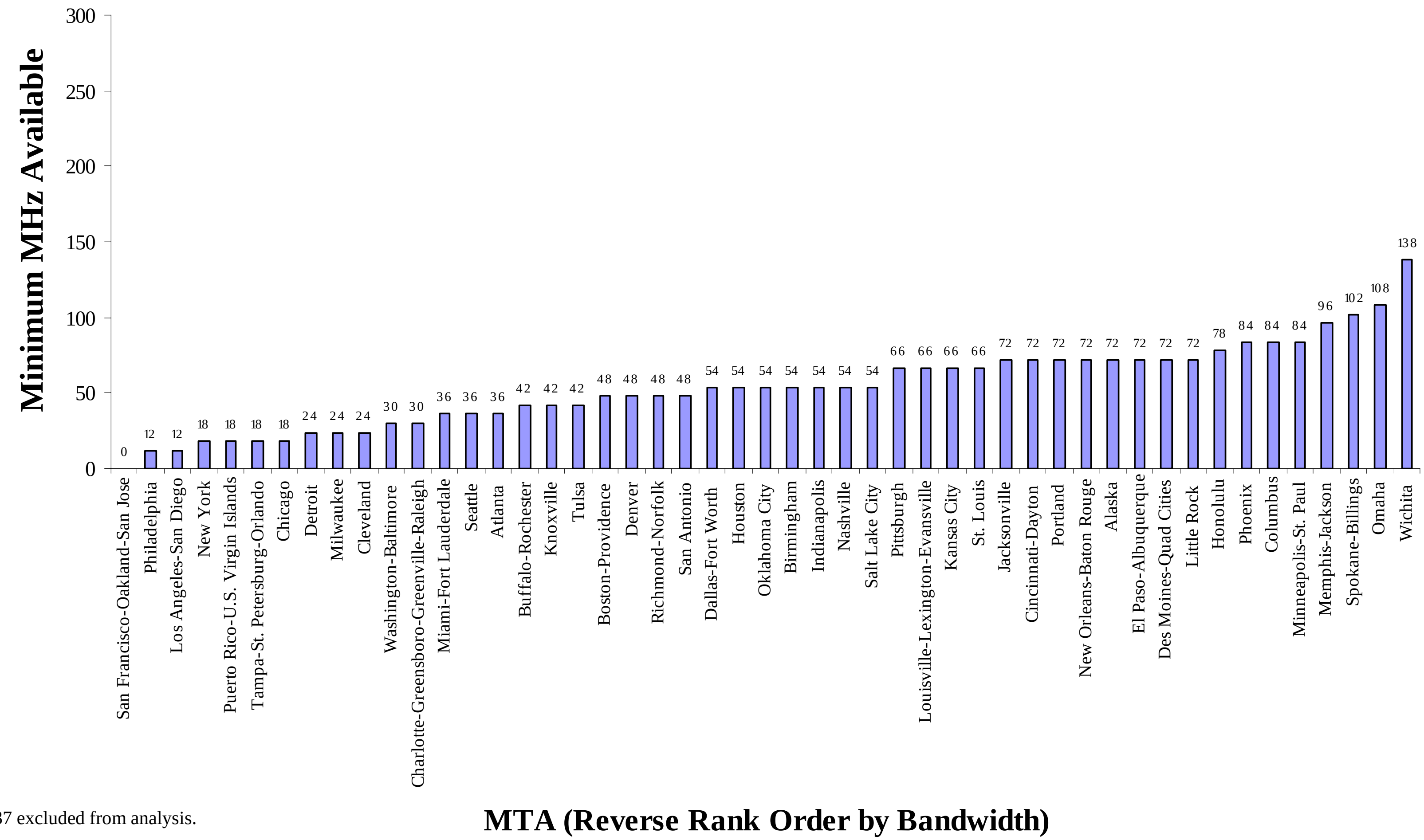
Note: Channel 37 excluded from analysis.

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

For Scenario Y, we estimate there will be at least 12 MHz of white space available everywhere except in portions of the San Francisco MTA.

Scenario X
Scenario Y
Scenario Z
Scenario UL-1
Scenario UL-2

Minimum Bandwidth of White Space by MTA



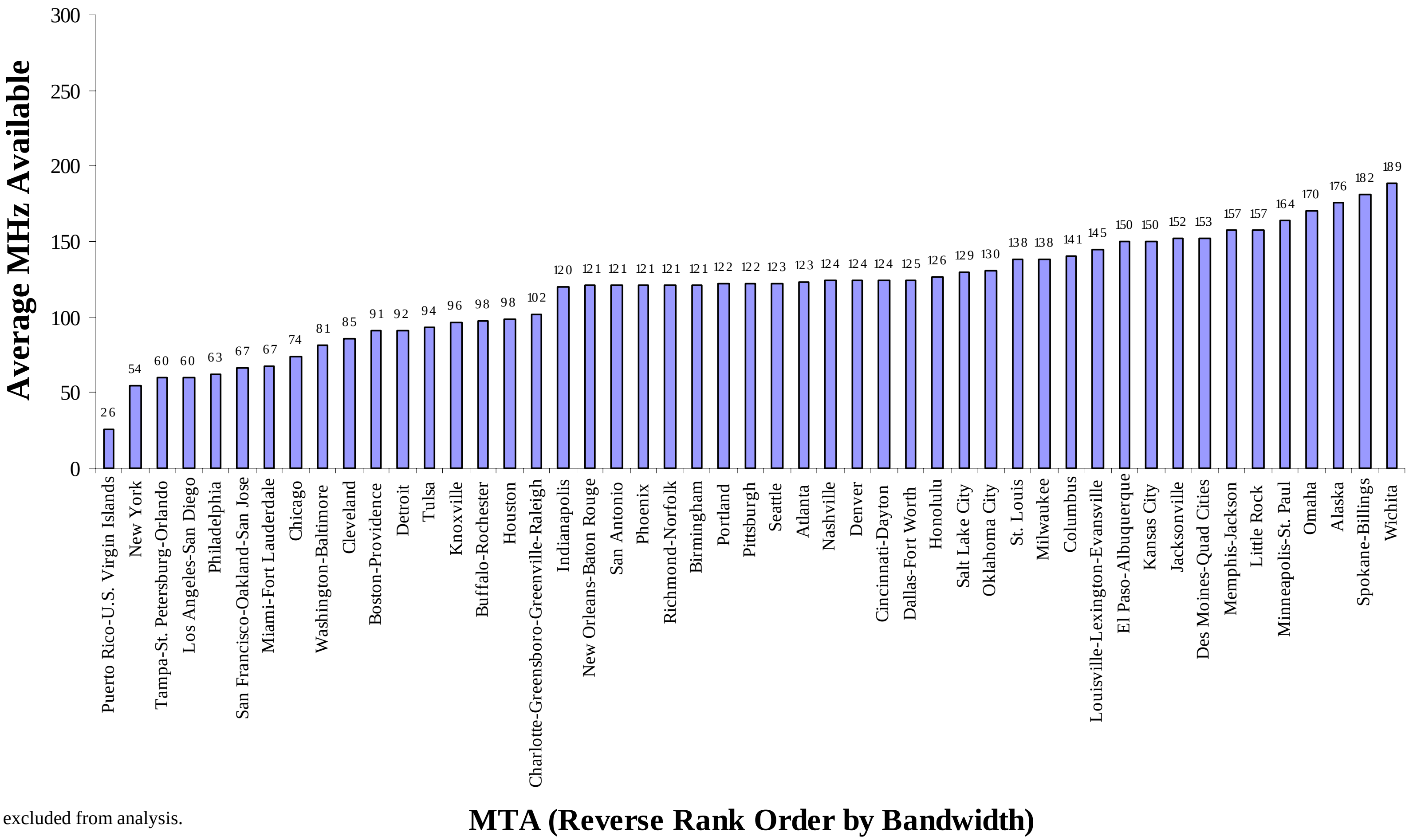
Note: Channel 37 excluded from analysis.

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

We estimate there will be an average of 99 MHz of white space, with about 50-60 MHz in the most concentrated MTAs.

Average Bandwidth of White Space by MTA

Scenario X
Scenario Y
Scenario Z
Scenario UL-1
Scenario UL-2



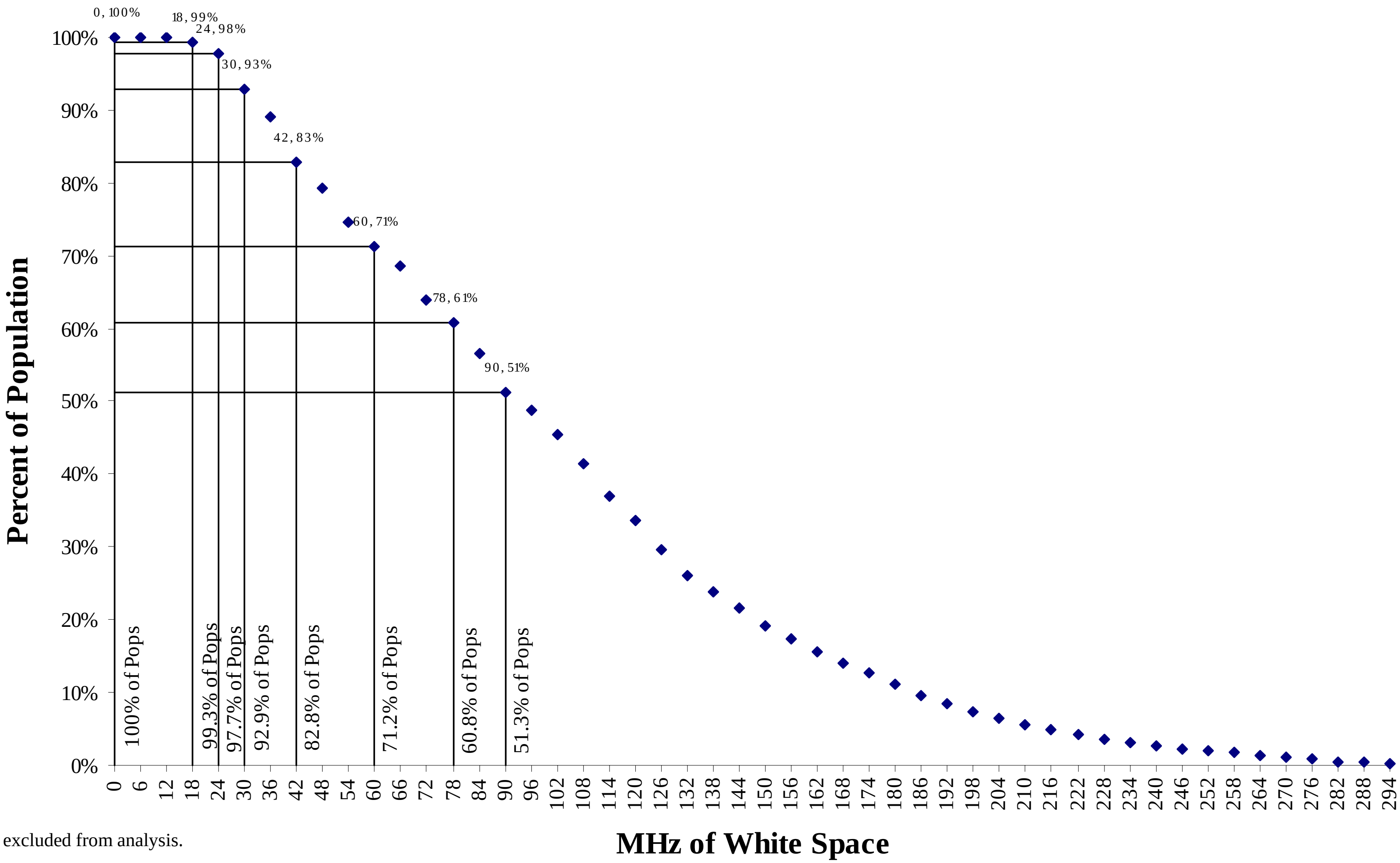
Note: Channel 37 excluded from analysis.

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

For channels 2-51, we estimate that 24 MHz of white space will be available to 95% of the US population.

Scenario X
Scenario Y
Scenario Z
Scenario UL-1
Scenario UL-2

Percent of Population with a Given Amount of White Space



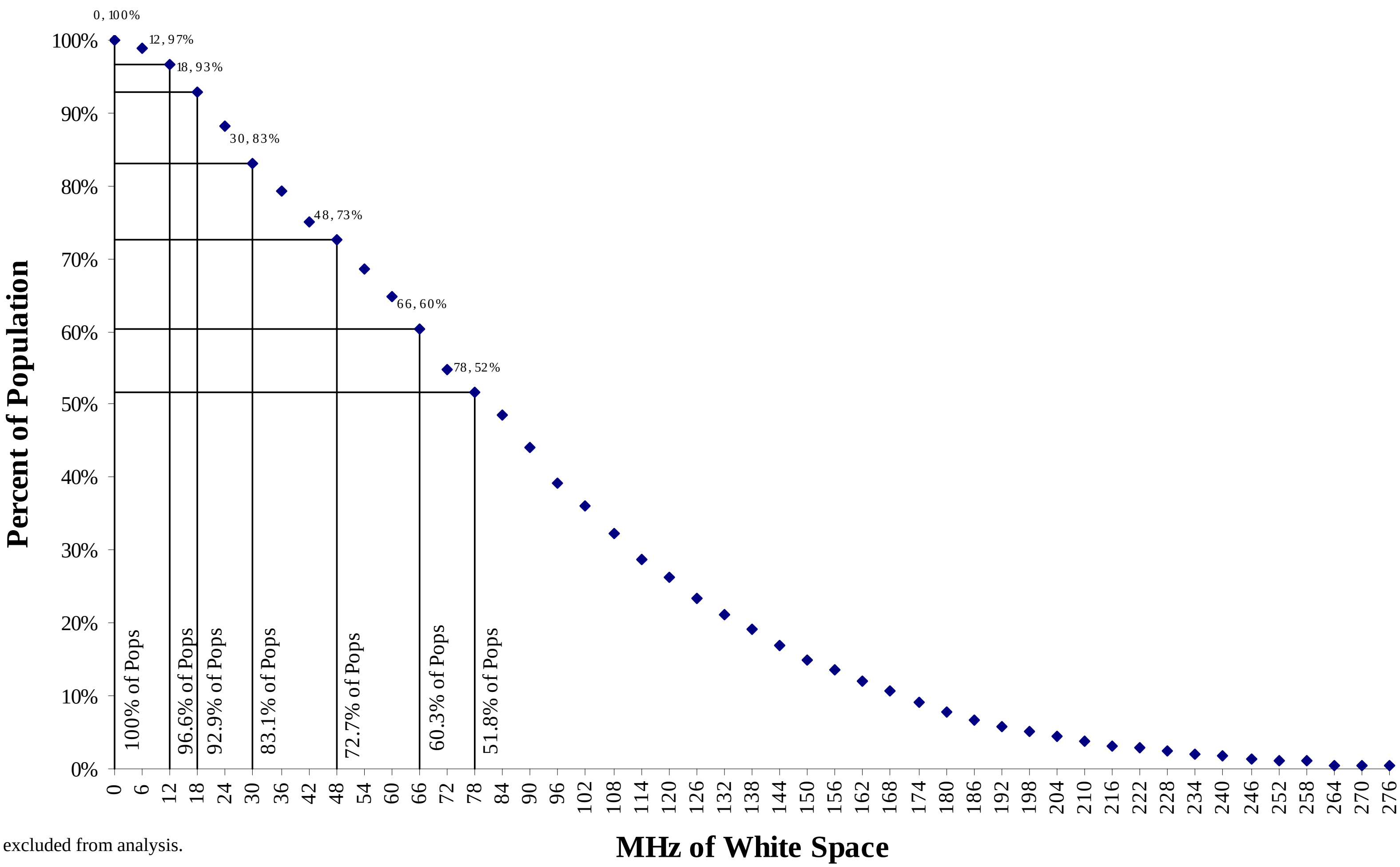
Note: Channel 37 excluded from analysis.

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

For channels 5-51, we estimate that 12 MHz of white space will be available to 95% of the US population.

Scenario X
Scenario Y
Scenario Z
Scenario UL-1
Scenario UL-2

Percent of Population with a Given Amount of White Space



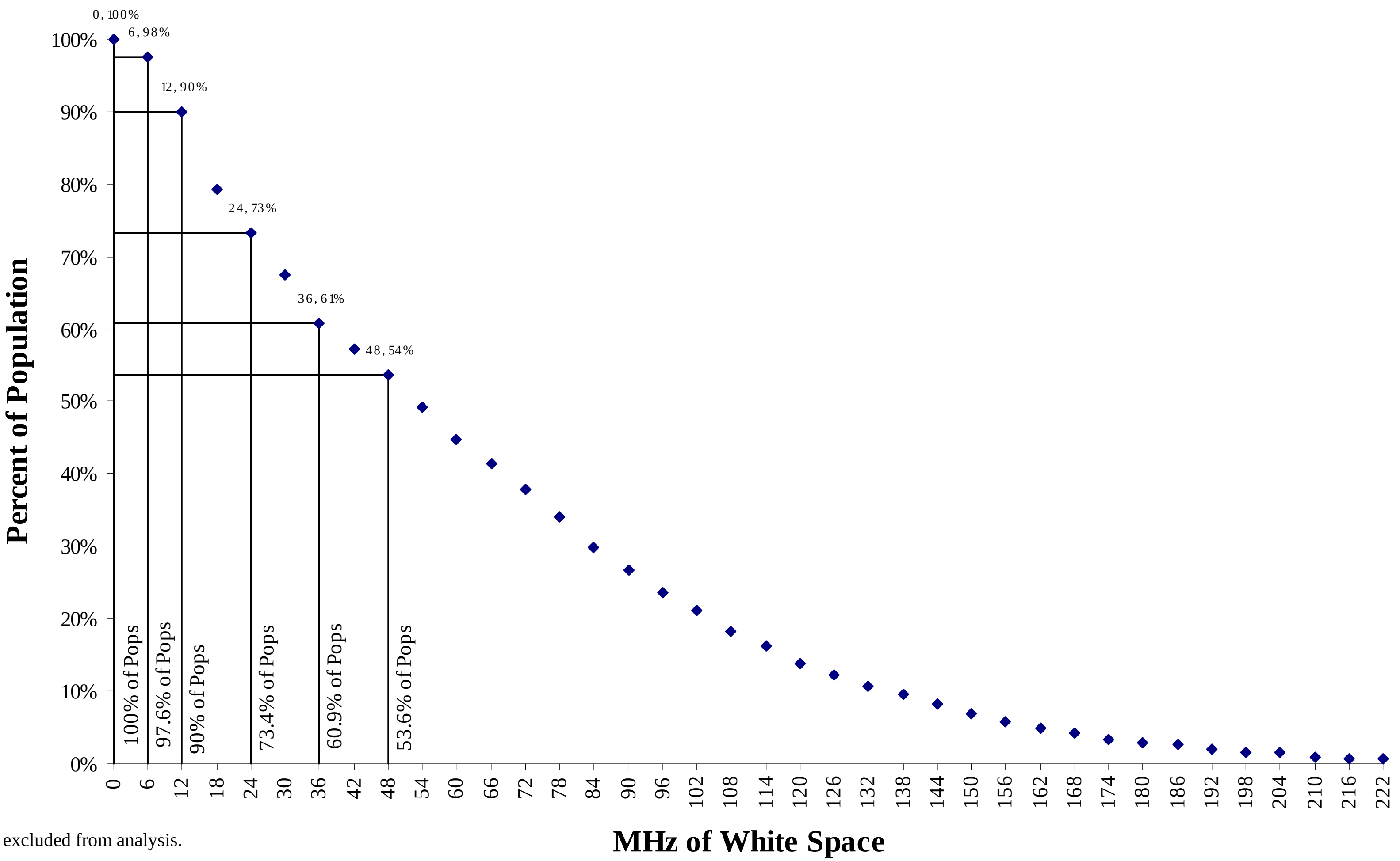
Note: Channel 37 excluded from analysis.

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

For channels 14-51, we estimate that 6 MHz of white space will be available to 95% of the US population.

Scenario X
Scenario Y
Scenario Z
Scenario UL-1
Scenario UL-2

Percent of Population with a Given Amount of White Space

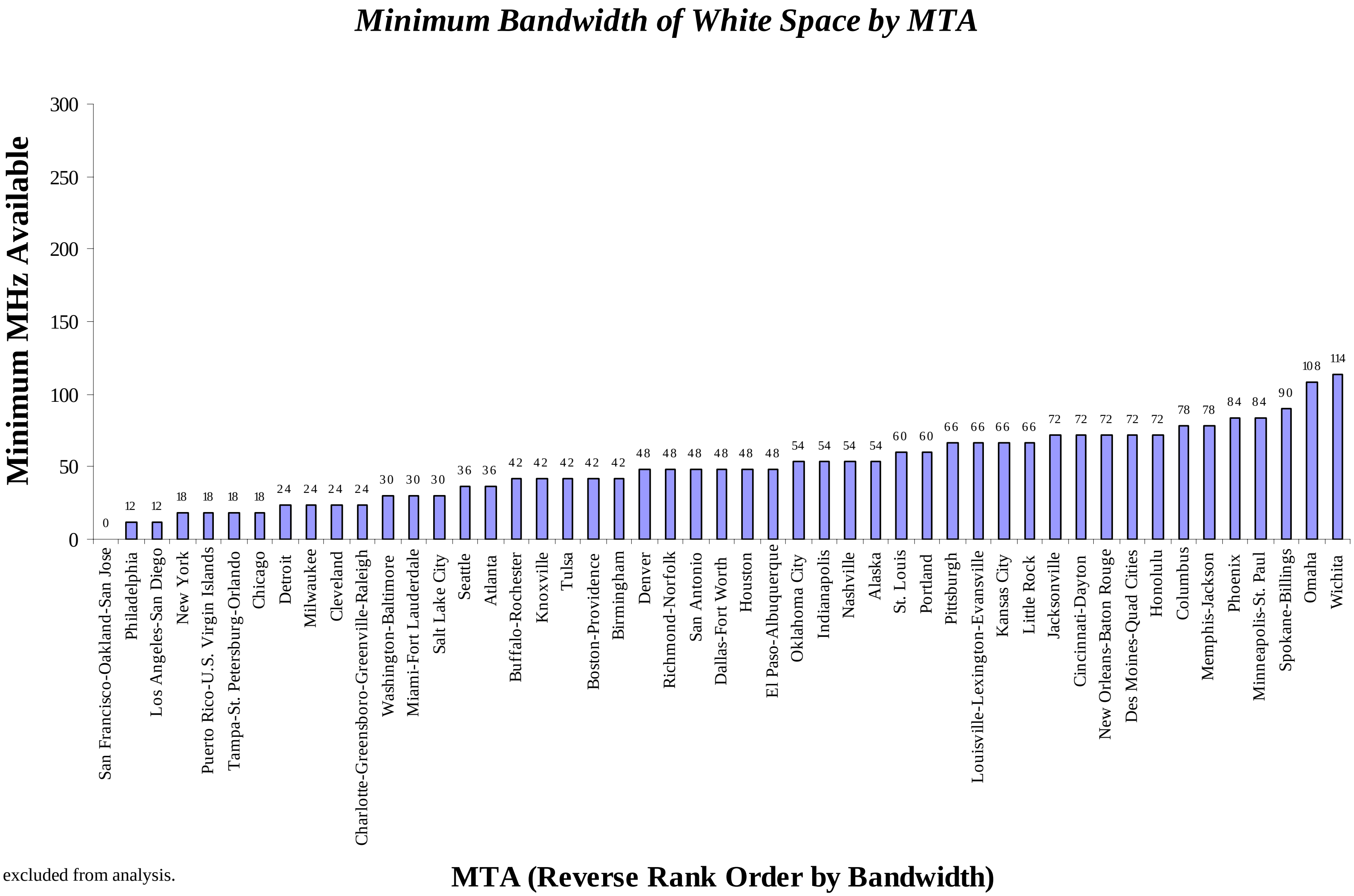


Note: Channel 37 excluded from analysis.

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

For Scenario Z, we estimate there will be at least 12 MHz of white space available everywhere except in portions of the San Francisco MTA.

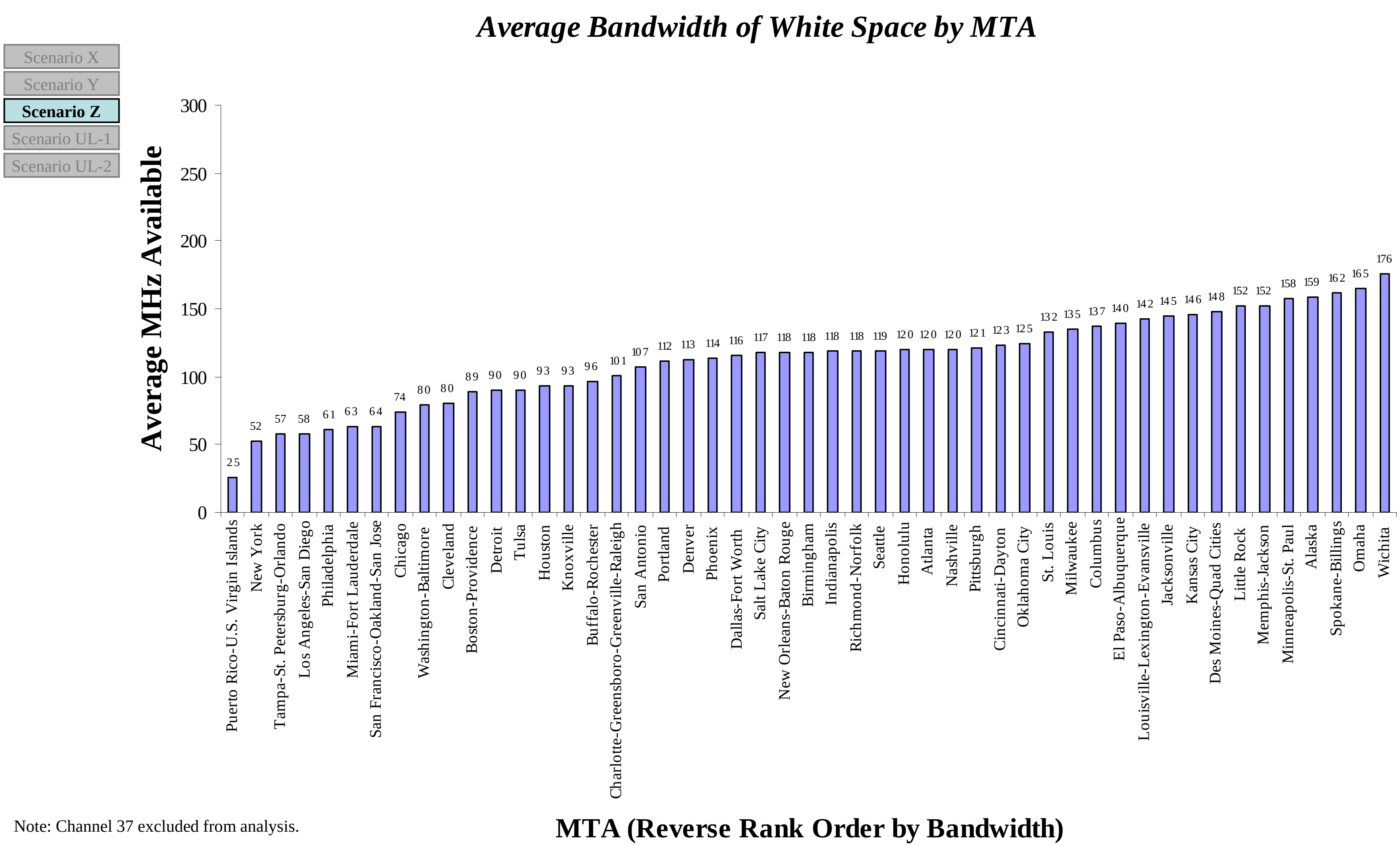
Scenario X
Scenario Y
Scenario Z
Scenario UL-1
Scenario UL-2



Note: Channel 37 excluded from analysis.

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

We estimate there will be an average of 95 MHz of white space, with about 50-60 MHz in the most concentrated MTAs.



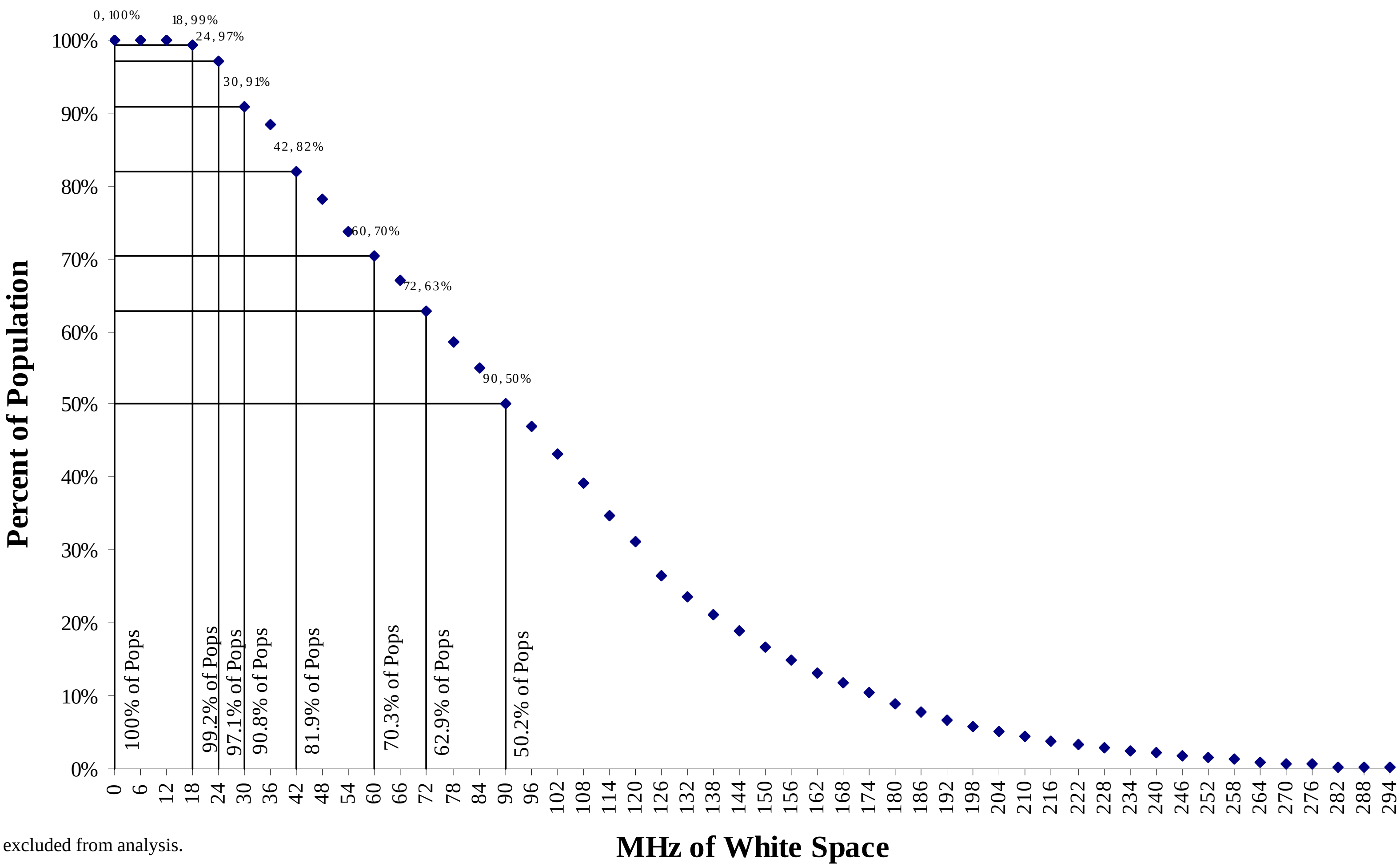
Note: Channel 37 excluded from analysis.

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

For channels 2-51, we estimate that 24 MHz of white space will be available to 95% of the US population.

Scenario X
Scenario Y
Scenario Z
Scenario UL-1
Scenario UL-2

Percent of Population with a Given Amount of White Space



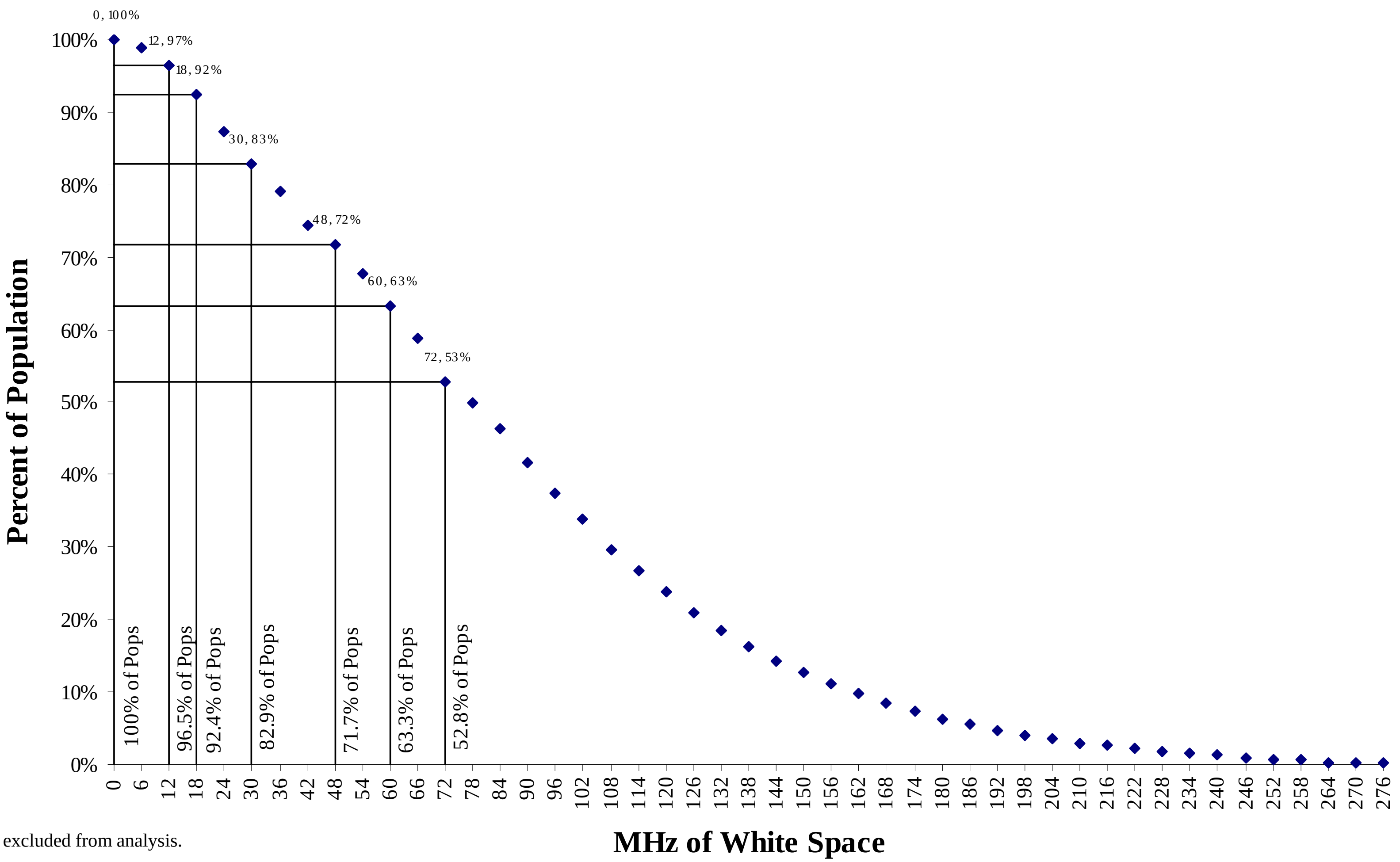
Note: Channel 37 excluded from analysis.

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

For channels 5-51, we estimate that 12 MHz of white space will be available to 95% of the US population.

Scenario X
Scenario Y
Scenario Z
Scenario UL-1
Scenario UL-2

Percent of Population with a Given Amount of White Space



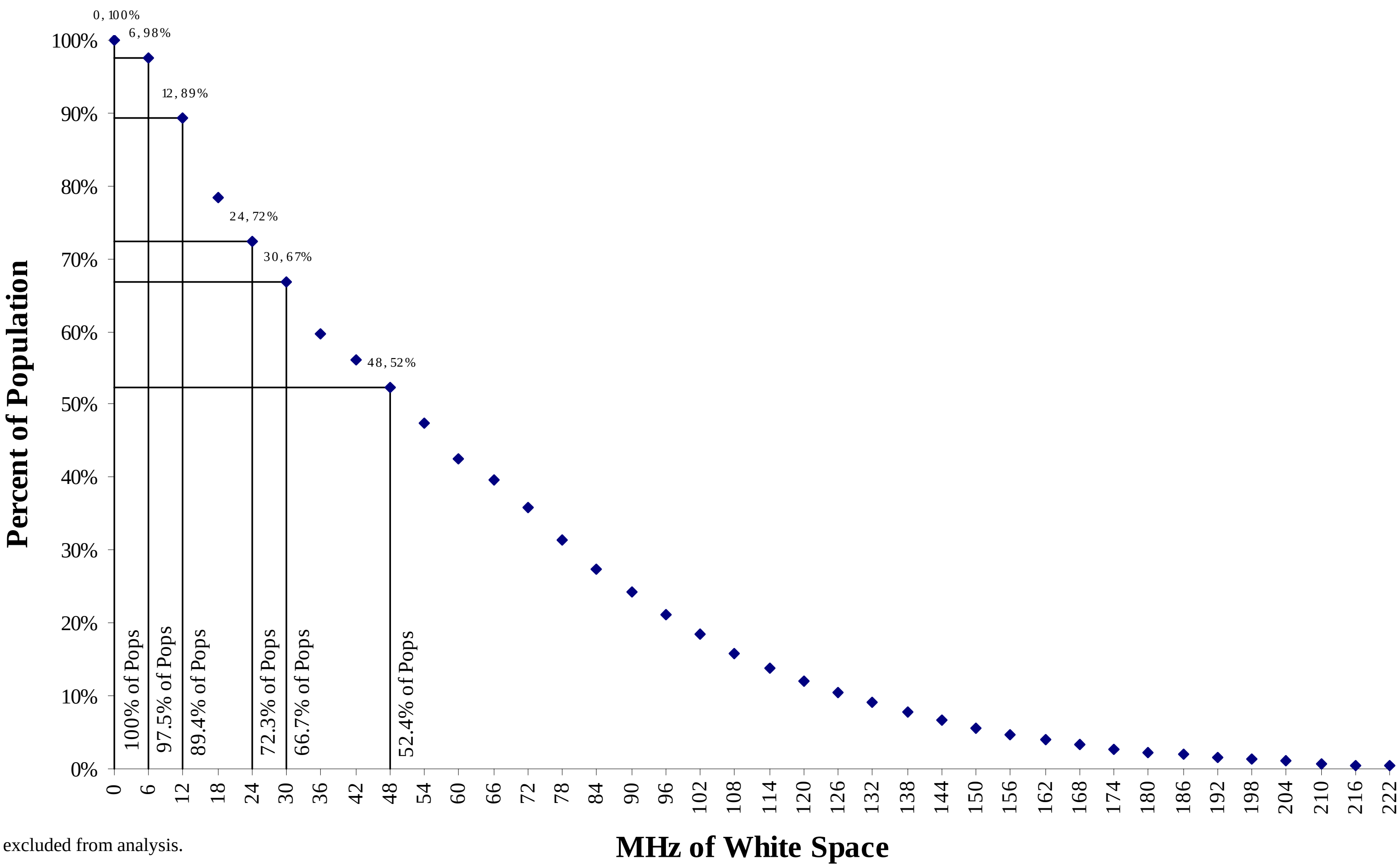
Note: Channel 37 excluded from analysis.

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

For channels 14-51, we estimate that 6 MHz of white space will be available to 95% of the US population.

Percent of Population with a Given Amount of White Space

Scenario X
Scenario Y
Scenario Z
Scenario UL-1
Scenario UL-2



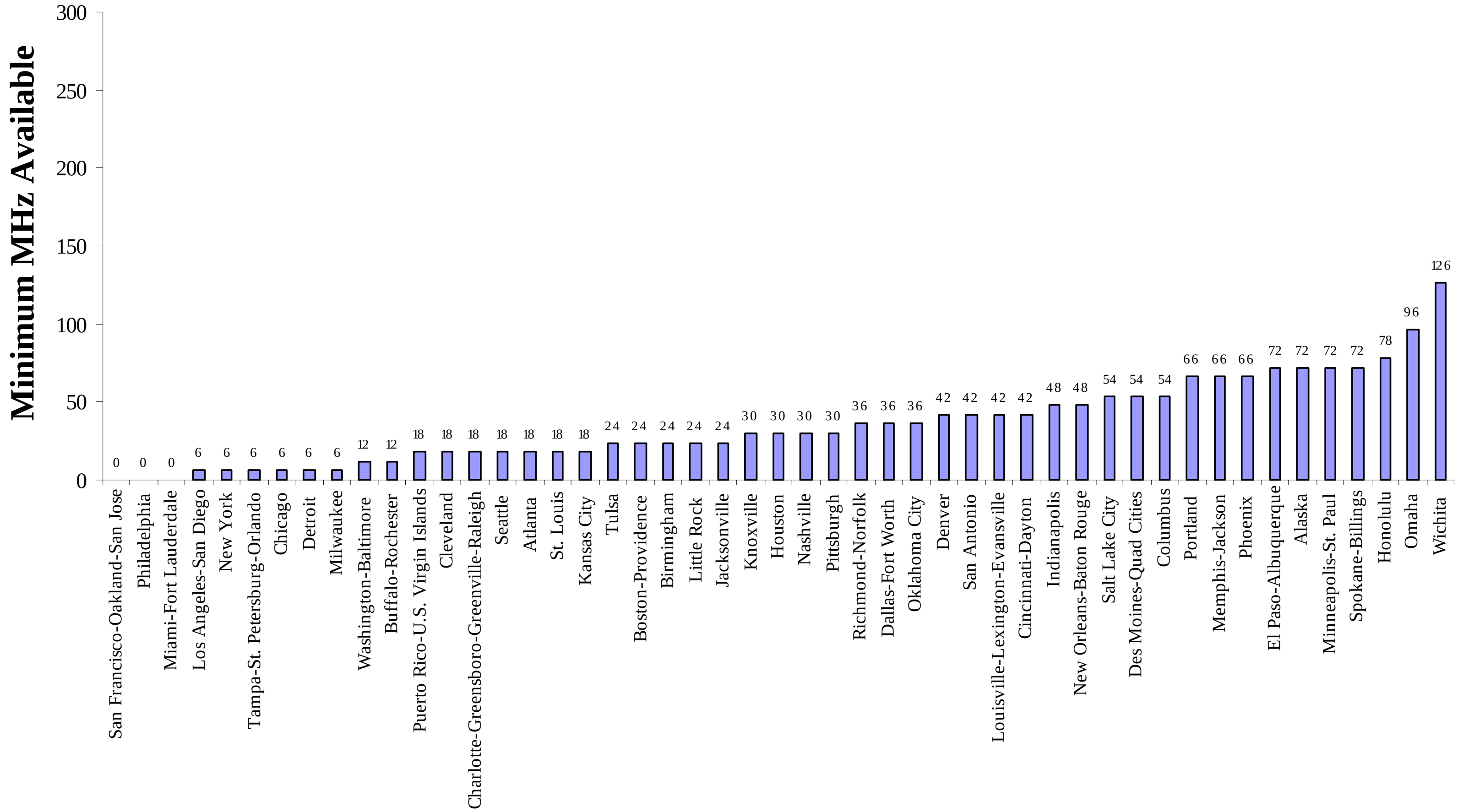
Note: Channel 37 excluded from analysis.

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

For Scenario UL-1, we estimate there will be at least 6 MHz of white space available everywhere except in portions of three MTAs.

Scenario X
Scenario Y
Scenario Z
Scenario UL-1
Scenario UL-2

Minimum Bandwidth of White Space by MTA



MTA (Reverse Rank Order by Bandwidth)

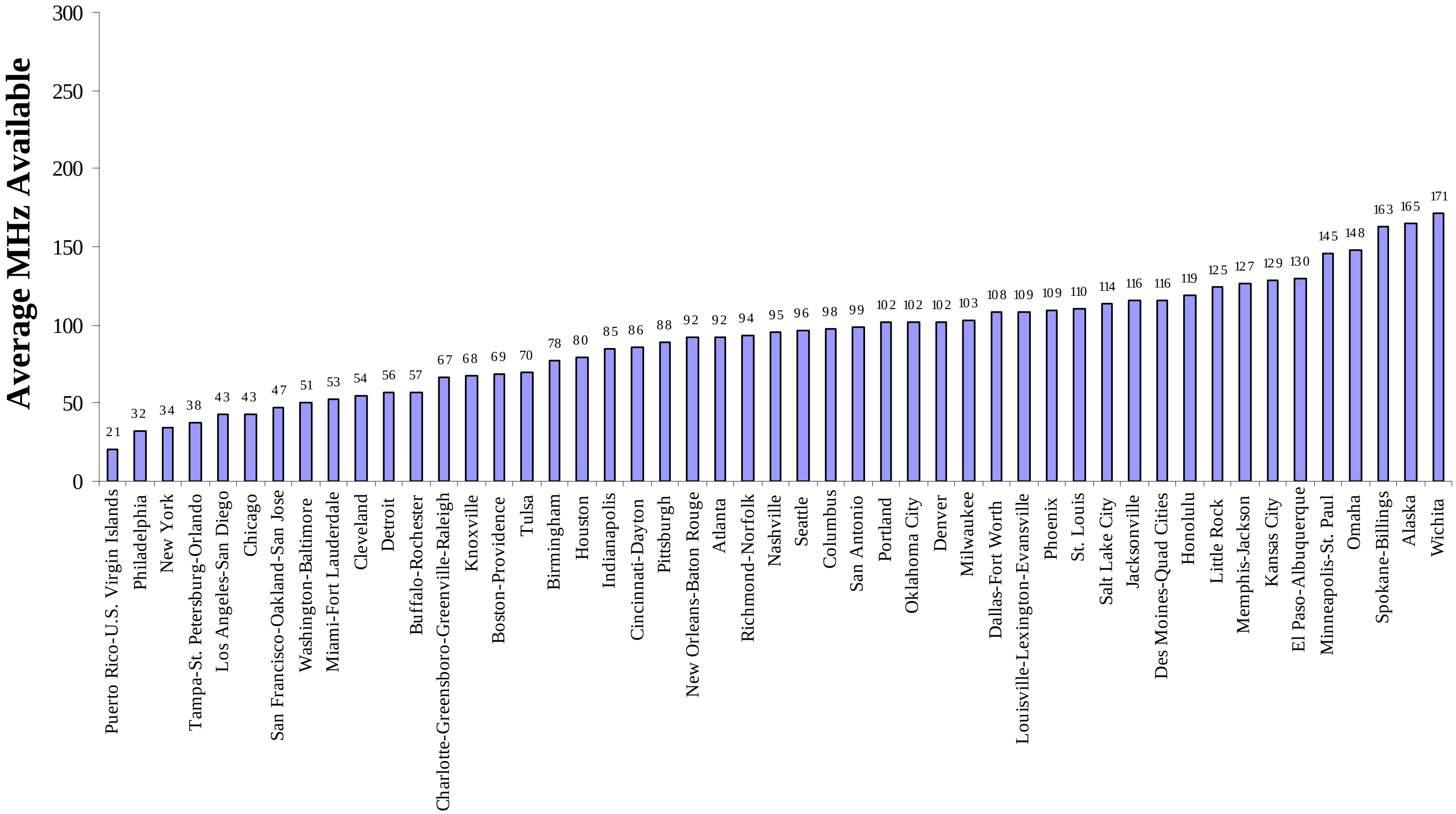
Note: Channel 37 excluded from analysis.

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

We estimate there will be an average of 74 MHz of white space, with about 30-40 MHz in the most concentrated MTAs.

Scenario X
Scenario Y
Scenario Z
Scenario UL-1
Scenario UL-2

Average Bandwidth of White Space by MTA



MTA (Reverse Rank Order by Bandwidth)

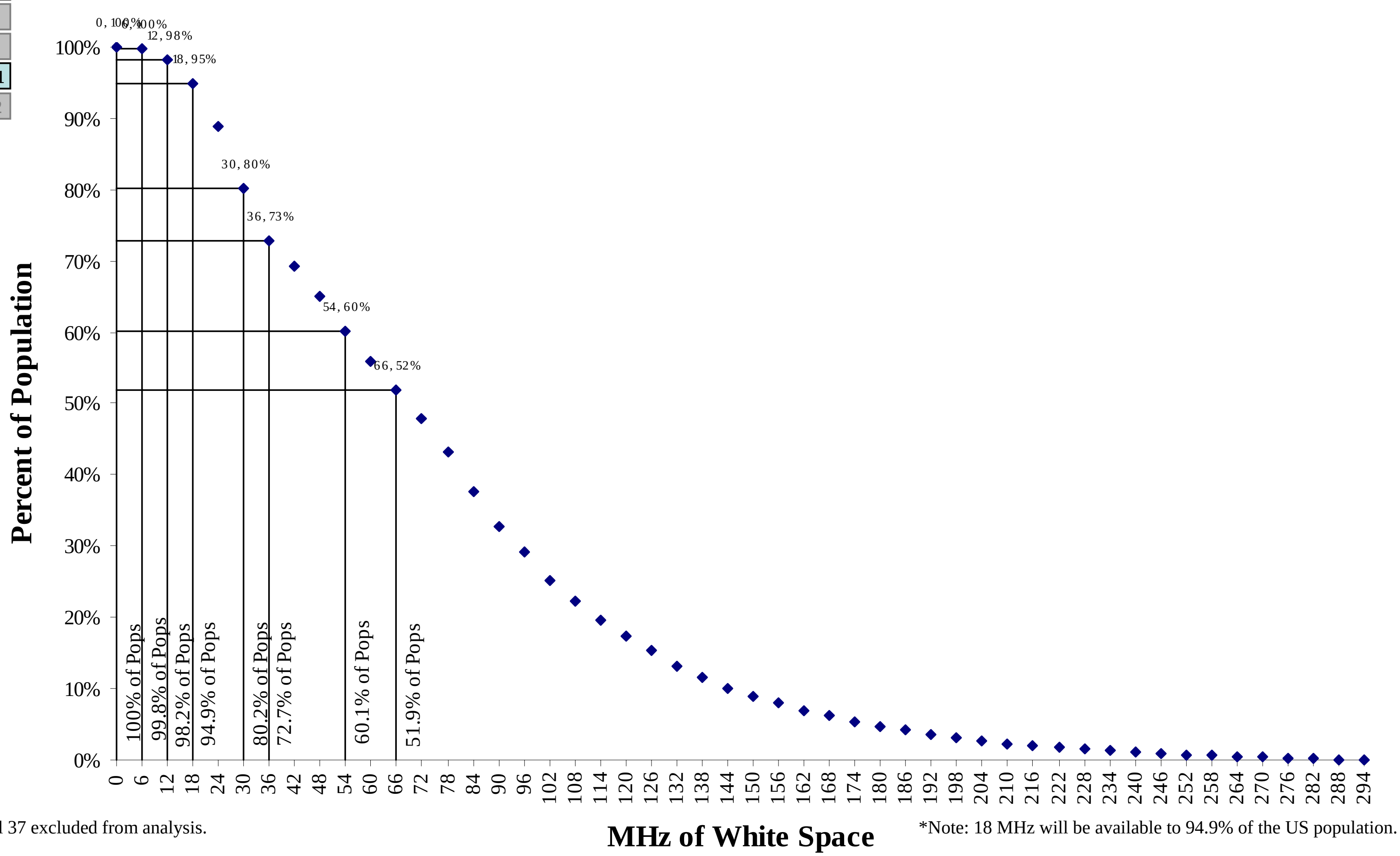
Note: Channel 37 excluded from analysis.

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

For channels 2-51, we estimate that 12 MHz of white space will be available to 95%* of the US population.

Scenario X
Scenario Y
Scenario Z
Scenario UL-1
Scenario UL-2

Percent of Population with a Given Amount of White Space



Note: Channel 37 excluded from analysis.

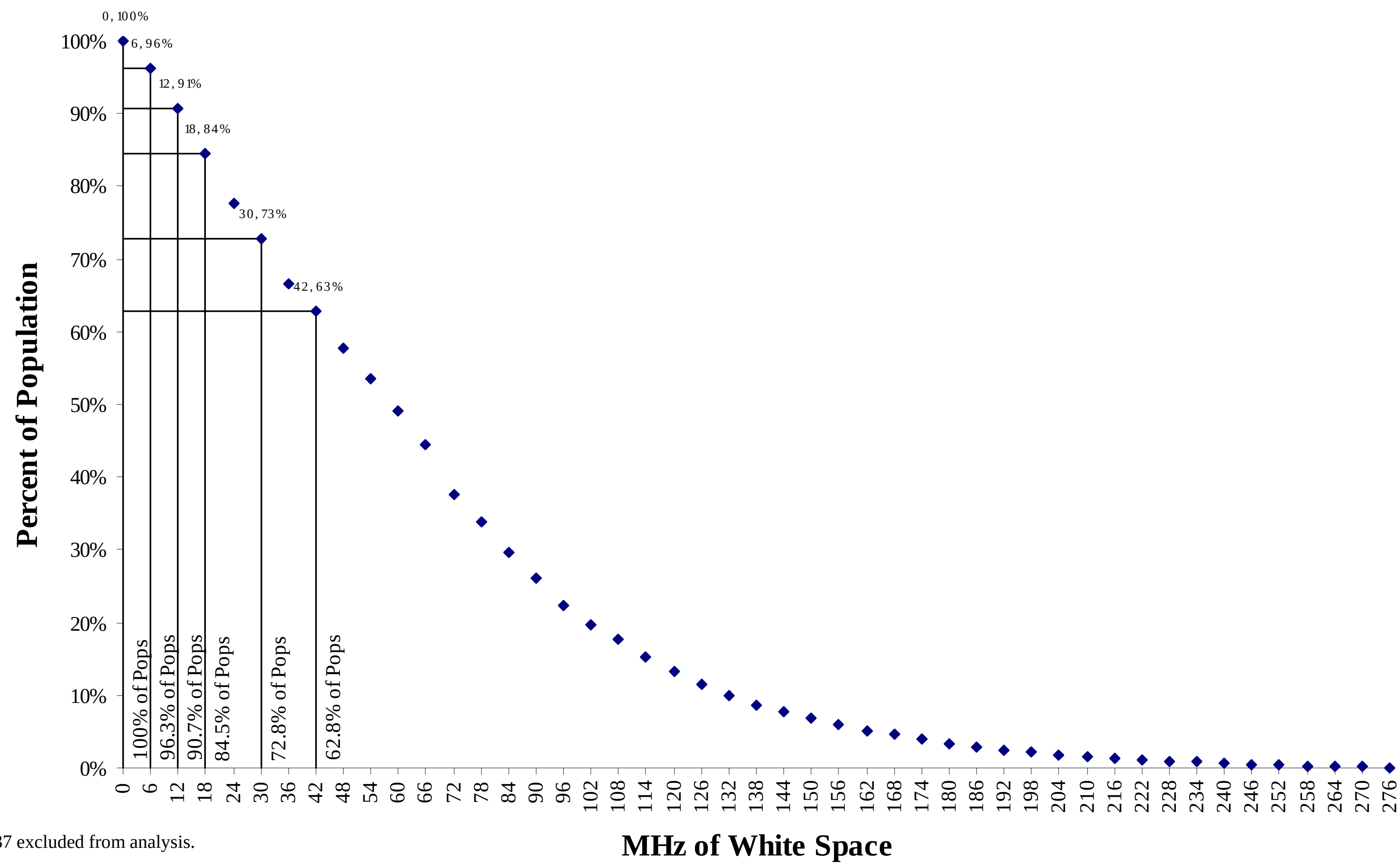
*Note: 18 MHz will be available to 94.9% of the US population.

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

For channels 5-51, we estimate that 6 MHz of white space will be available to 95% of the US population.

Scenario X
Scenario Y
Scenario Z
Scenario UL-1
Scenario UL-2

Percent of Population with a Given Amount of White Space



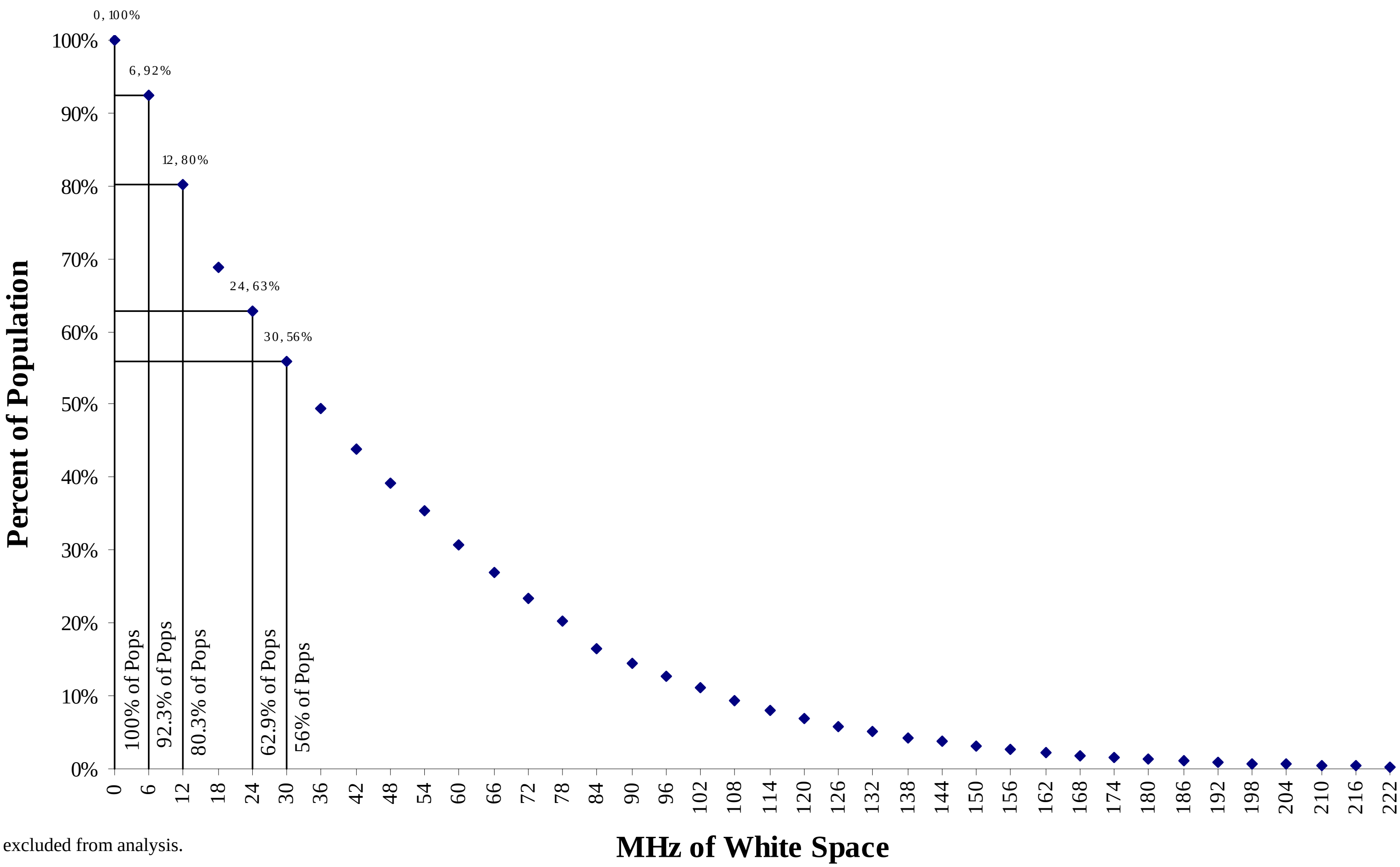
Note: Channel 37 excluded from analysis.

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

For channels 14-51, we estimate that 0 MHz of white space will be available to 95% of the US population.

Scenario X
Scenario Y
Scenario Z
Scenario UL-1
Scenario UL-2

Percent of Population with a Given Amount of White Space



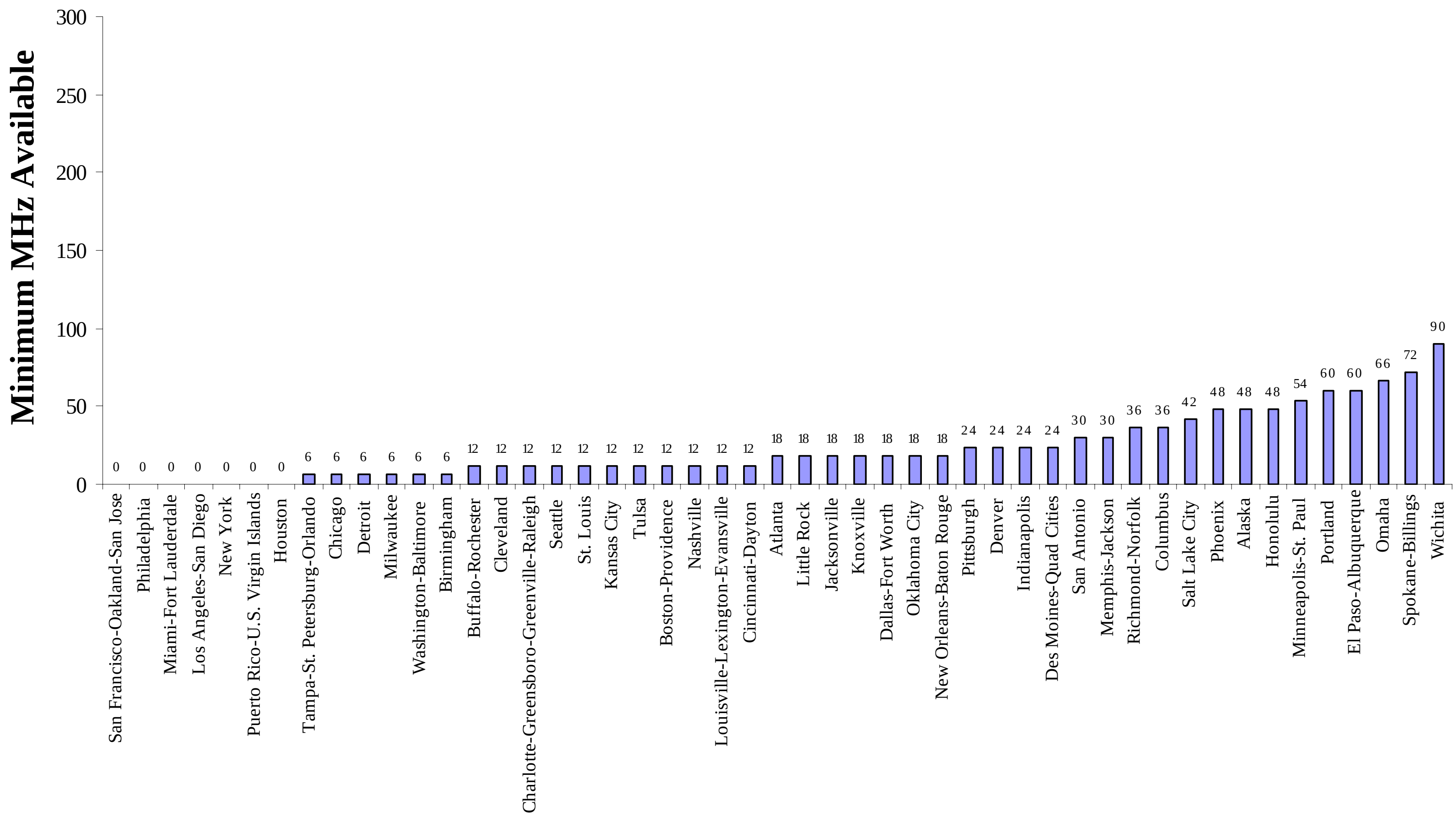
Note: Channel 37 excluded from analysis.

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

For Scenario UL-2, we estimate there will be at least 6 MHz of white space available everywhere except in portions of seven MTAs.

Scenario X
Scenario Y
Scenario Z
Scenario UL-1
Scenario UL-2

Minimum Bandwidth of White Space by MTA



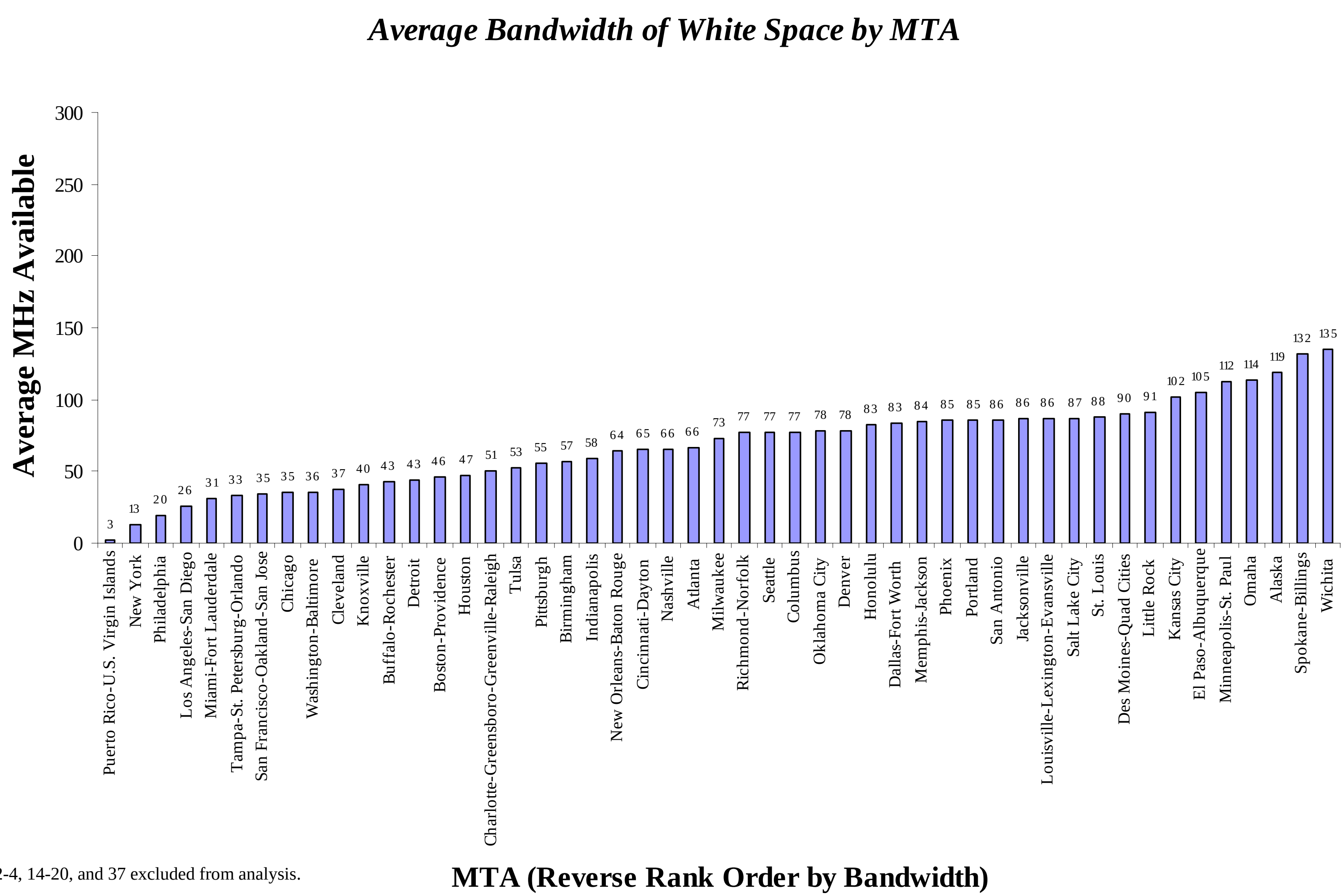
Note: Channels 2-4, 14-20, and 37 excluded from analysis.

MTA (Reverse Rank Order by Bandwidth)

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

We estimate there will be an average of 53 MHz of white space, with about 20-30 MHz in the most concentrated MTAs.

Scenario X
Scenario Y
Scenario Z
Scenario UL-1
Scenario UL-2



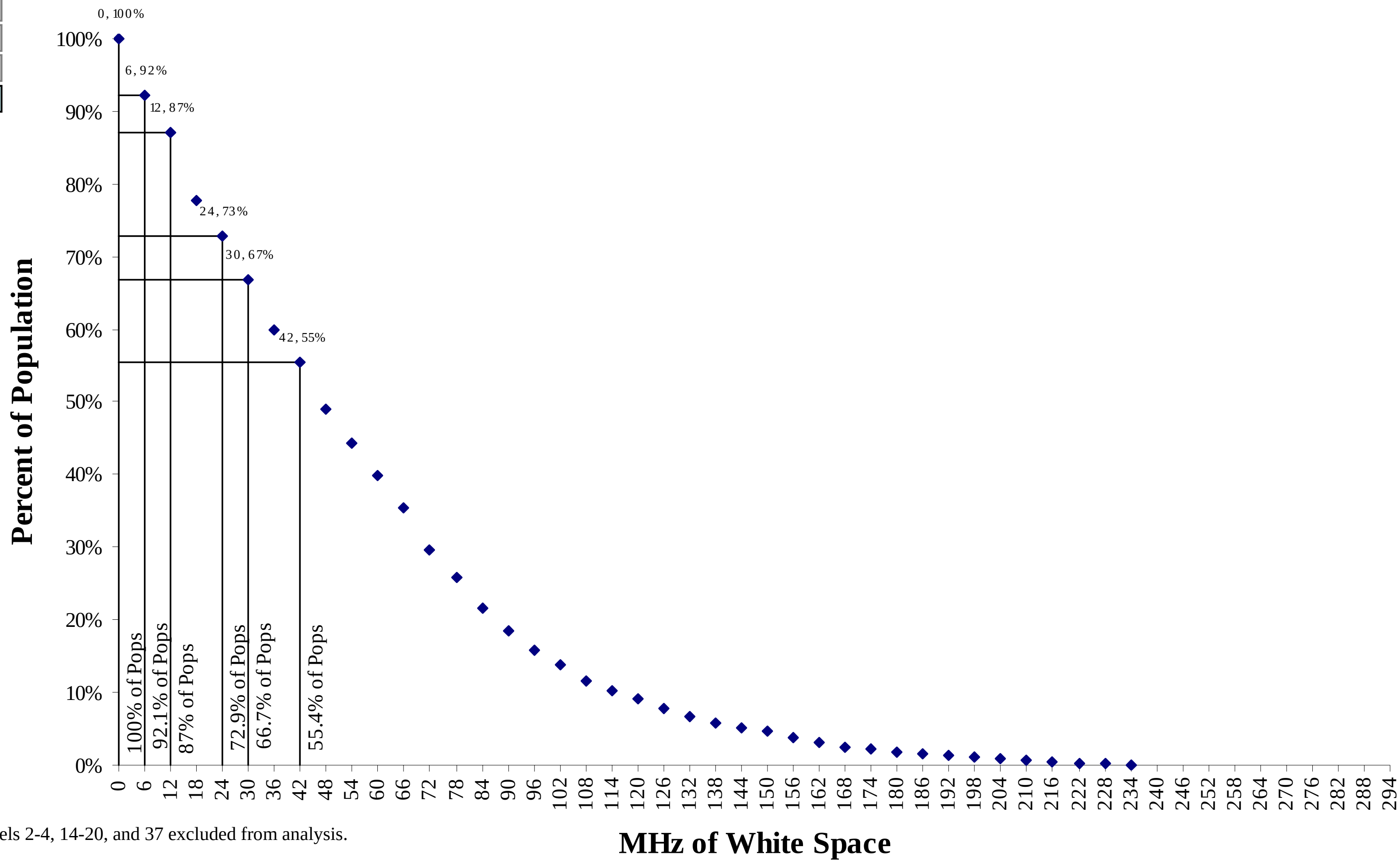
Note: Channels 2-4, 14-20, and 37 excluded from analysis.

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

For channels 2-51*, we estimate that 0 MHz of white space will be available to 95% of the US population.

Scenario X
Scenario Y
Scenario Z
Scenario UL-1
Scenario UL-2

Percent of Population with a Given Amount of White Space

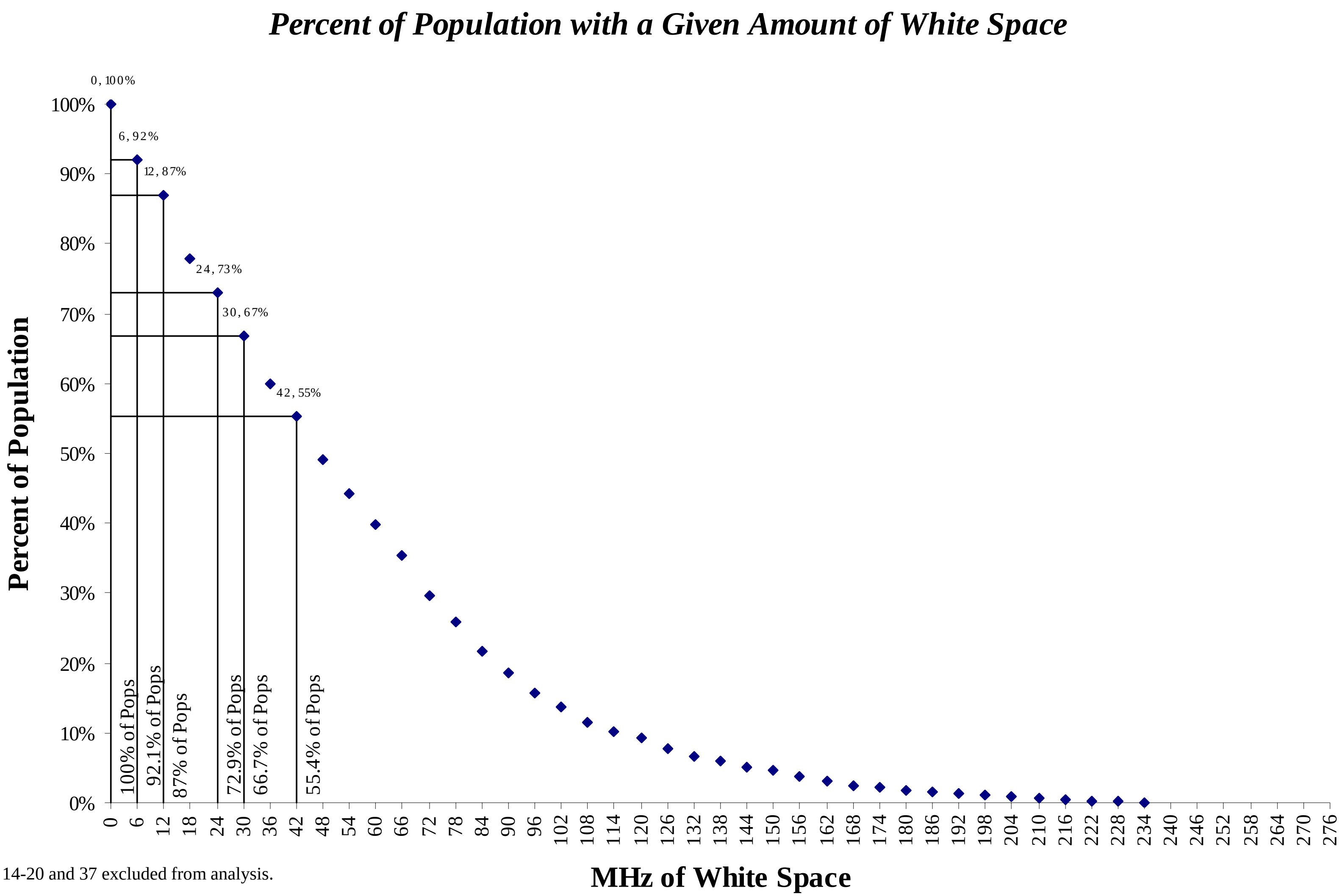


*Note: Channels 2-4, 14-20, and 37 excluded from analysis.

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

For channels 5-51*, we estimate that 0 MHz of white space will be available to 95% of the US population.

Scenario X
Scenario Y
Scenario Z
Scenario UL-1
Scenario UL-2



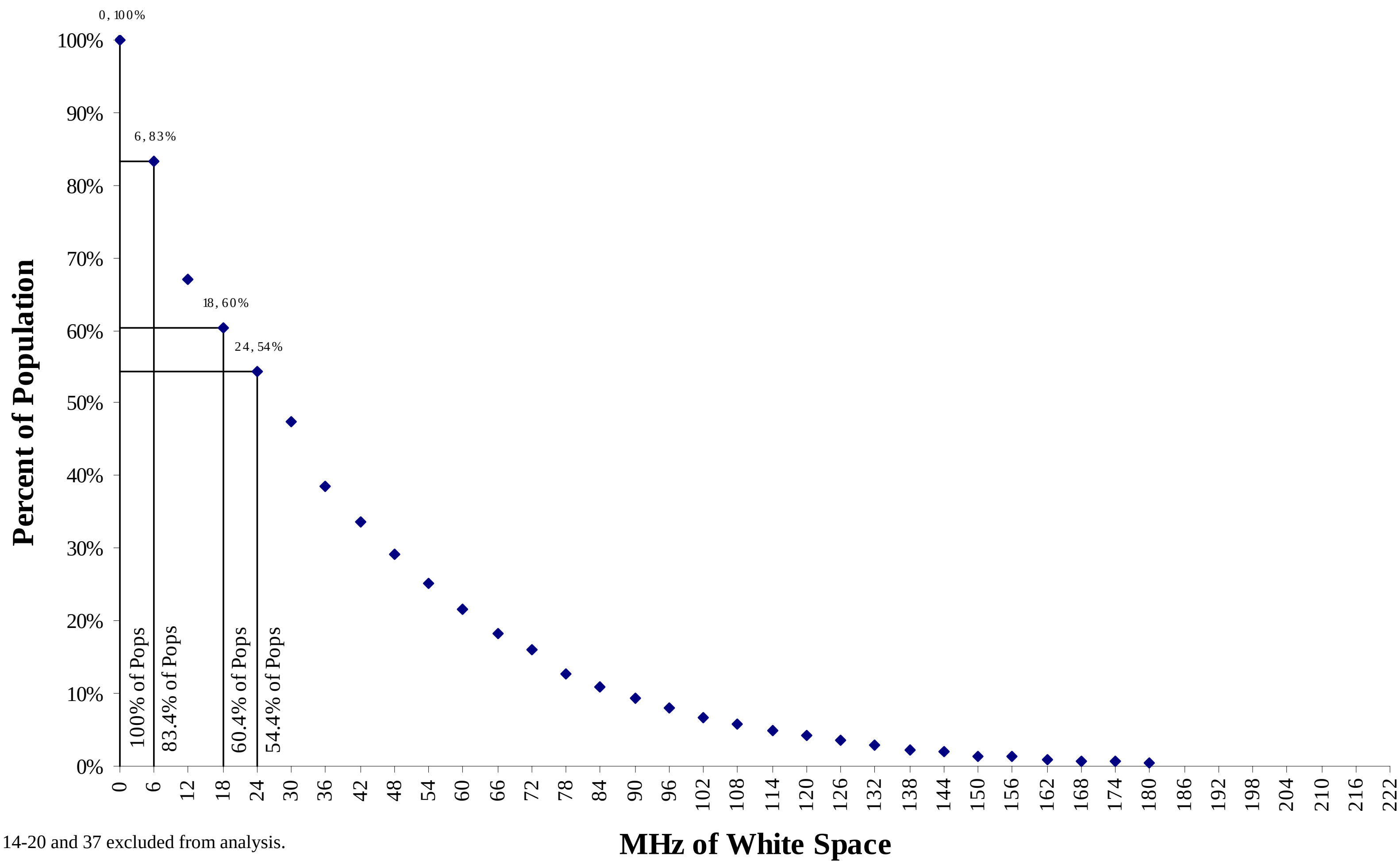
*Note: Channels 14-20 and 37 excluded from analysis.

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

For channels 14-51*, we estimate that 0 MHz of white space will be available to 95% of the US population.

Percent of Population with a Given Amount of White Space

Scenario X
Scenario Y
Scenario Z
Scenario UL-1
Scenario UL-2



*Note: Channels 14-20 and 37 excluded from analysis.

Source: FCC CDBS / TV Query; US Census; Brattle Group Analysis

Appendix Contents

- Methodology
- Results
- General Observations

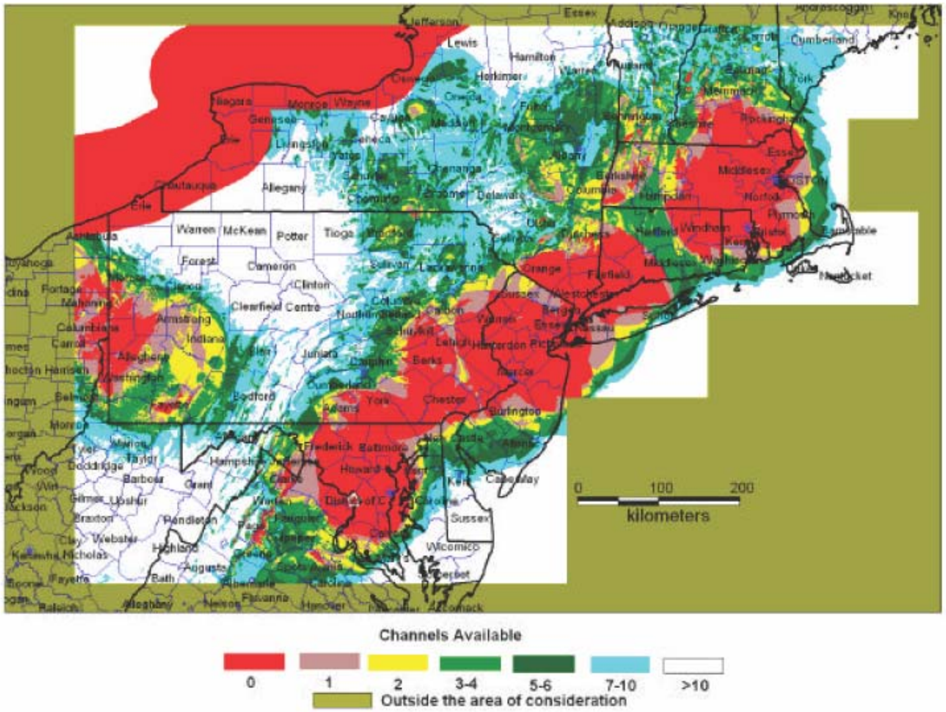
A few caveats …our results are approximate. We believe that the overall national figures are reasonably accurate. However the results for any one MTA will exhibit greater variability around the actual values than do the national results. A variety of factors limit our ability to predict with more accuracy.

- Whereas MSTV calculated interference effects using data on actual terrain along the propagation path, as a short cut, we used height above average terrain as listed in the FCC records.
- The list of post-transition licensees is still in flux.
- The post-transition operation of translators is necessarily speculative—the FCC is in the process of licensing translators for post-transition operation. We have estimated the future operation of translators based on current practices.
- Uncertainty about the FCC's interference rules is another limiting factor, although we have taken account of that by estimating white space under alternative interference rules (our five different scenarios).

MSTV Study Approach - MSTV filed an engineering study in January 2005 in FCC Docket 04-186.

MSTV White Space Estimate

- MSTV's study did an enormous computation in order to identify those locations where an unlicensed device could operate without being likely to cause interference to DTV reception. The study found few free channels in urban areas in the Northeast. Figure 6 from the study is reproduced here. It shows the white space in the North Eastern United States.
- The MSTV study differed from ours in several respects — perhaps the largest difference is that it assumes that an unlicensed device would operate as the FCC proposed — with radiated power (EIRP) of up to 4 watts in the direction of a DTV receiver.
- In contrast, we assumed that a licensee would engineer applications to efficiently use the white space; using directional antennas, lowered power, and terrain shielding in order to expand the service area as close the edge of the station's protected contour without causing interference.



Attachment 2

Digital Dividend Review

A statement on our approach to awarding the digital dividend

Statement

Publication date: 13 December 2007

Contents

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1	Executive summary	3
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Foreword

This statement sets out one of the most important decisions we have ever made: how to award the spectrum freed up by digital switchover (DSO)—the digital dividend—for new uses. This has been the focus of our Digital Dividend Review (DDR) since it was launched two years ago.

This decision matters for several reasons:

- spectrum is an essential input in the modern world. Its use underpins 3% of the UK's gross domestic product (GDP) and generates wide reaching benefits for citizens and consumers. But spectrum is a scarce resource, so how it is managed is a critical issue;

- the spectrum presently used by analogue terrestrial television is exceptional because it can readily be used to provide high bandwidth services over long distances and into buildings; and

- the opportunity to put this spectrum to new use does not arise often. Analogue television has been its main use for many decades, under a framework that dates back to 1961.

Most of the spectrum used for analogue television has already been set aside for digital terrestrial television (DTT) at DSO: 256 MHz out of a total of 368 MHz. This will allow a major expansion of the capacity and coverage of DTT.

Our main task in the DDR has been to decide how to release the remainder of this spectrum. This could be put to new uses as varied as mobile broadband, mobile television, more DTT and new "cognitive" wireless services.

Under the Communications Act 2003, our duties are to further the interests of citizens and consumers and to secure the optimal use of spectrum. Our objective for the DDR is to award the digital dividend in a way that maximises the total value to society from its future use. This includes value both to citizens and to consumers. It is expressly not our aim to raise revenue for the Government.

We published proposals for consultation in December 2006. These set out a market led approach, moving away from the command and control regime of the past. Instead of the regulator deciding who could use spectrum, how and for what, we favoured giving users the flexibility to decide how spectrum should be used and the ability to change that use over time as technologies and needs change. This is likely to generate greater value for citizens and consumers.

We also recognised that markets do not work perfectly. We set out proposals to address issues faced by smaller users in particular, like the programme making and special events (PMSE) sector and potential operators of local television.

Our proposals generated over 750 responses and a lively debate. Many stakeholders supported a market led approach, but others called on us to intervene. We had requests to reserve spectrum for many different uses and users, for a range of different reasons. There was particular concern about the prospects for DTT services in high definition (HD) and more generally about how broader social value would be delivered within a market led approach. We also received comments on our proposals for PMSE and local television. The timing of the award was a key issue for many respondents: some argued for it to be brought forward, others for delay. Separately, both the Government and the House of Commons Select Committee for Culture, Media and Sport declared their support for a service and technology neutral auction of the digital dividend.

Since consultation, we have undertaken a significant body of new work:

- we have conducted a separate, detailed consultation on spectrum access for PMSE;
- we have published detailed proposals to upgrade the DTT platform by using new technologies. These will enable a richer and more varied set of services, including HD, without needing extra spectrum;
- we have conducted more market research, responding to comments on our methodology. The new research nonetheless came to similar conclusions, with no single service commanding overwhelming support from citizens and consumers; and
- we have conducted further analysis, including economic modelling and technical analysis, of a wide range of issues.

In light of all the evidence available, we have concluded that we should take a market led approach to awarding the digital dividend. This means that, with one important exception, we will auction the spectrum in a way that allows users to decide how the spectrum should be used and creates the maximum flexibility and opportunities for different technologies and services.

We have carefully considered arguments for reserving spectrum for a variety of particular uses, but we have not found them compelling. Giving spectrum to one use will deny it to others. It will also tend to reduce flexibility and blunt incentives. We recognise that many services can provide broader social value, but we do not think that support via implicit subsidies in the form of spectrum is necessary to realise this. Explicit support through direct funding is more transparent and can achieve a better outcome.

The exception to our market led approach is for PMSE, which already uses interleaved spectrum on a large scale. This is an extremely diverse community, and we do not think it would be able to take part effectively in an auction, creating a serious risk of market failure. We will therefore hold a beauty contest to award a package of interleaved spectrum to meet PMSE users' needs.

This statement marks the end of the first phase of the DDR. But another, equally important phase is to come: the detailed design of the award process and the licences. Promoting competition and innovation will be at the heart of our work, and we will look carefully at how to encourage entry and guard against the risk of anticompetitive behaviour. Our experience suggests that, if spectrum auctions are well designed, they can be powerful tools for creating a more competitive landscape.

We thank all stakeholders for their engagement in the DDR to date and look forward to working closely with them in the months to come.

David Currie
Chairman

Ed Richards
Chief Executive

Section 1

Executive summary

Introduction

1.1 Demand for spectrum is growing quickly, fuelled by rapid innovation in wireless technologies and consumers' appetite for mobility. Wireless services are now widely available at low cost, to the benefit of both individuals and society as a whole.

1.2 But spectrum is a scarce resource, so the way it is managed and used is an important issue for advanced economies around the world. One of our key duties is to secure the optimal use of spectrum in the interests of the UK's citizens and consumers.

1.3 In the DDR, we have considered how we should award some of the most valuable spectrum likely to be released for new uses over the next 10 to 20 years. Consultation has been an essential element of our work, and our proposals generated over 750 responses from a wide variety of stakeholders expressing a wide range of views.

1.4 This statement sets out our answer to the fundamental question of whether we should intervene in awarding the digital dividend by favouring certain uses or users or whether we should take a market led approach, allowing the market to determine who should use the spectrum, how and for what.

The digital dividend

1.5 Analogue terrestrial television is currently the primary use of 368 MHz of spectrum in the UK. This represents just under half of the most useful spectrum available. Analogue television will cease when DSO ends in 2012.

1.6 The Government decided in 2003 that 256 MHz of this spectrum should be reserved for DTT at DSO. DTT is many times more efficient than analogue television, so many more services can be provided to viewers even while using less spectrum.

1.7 The Government's decision means that, at DSO, there will be a major expansion of the coverage and capacity of DTT. DTT will be universally available throughout the UK for the first time. In parallel, the capacity of the six DTT multiplexes will grow by at least 20%, enabling a wider and richer range of services without extra spectrum.

1.8 The Government also decided in 2003 that the 112 MHz that will be cleared of analogue television should be released for new uses. This cleared spectrum, with a few adjacent frequencies, forms the core of the digital dividend.

1.9 The way that DTT operates means that there is also a large amount of spare capacity within the 256 MHz reserved for it. This can be made available for new uses that will interleave (i.e. share) successfully with broadcast transmitters. This capacity is known as interleaved spectrum.

1.10 We have considered the future of both cleared and interleaved spectrum as part of the DDR. Together, they constitute the digital dividend.

1.11 The fundamental reason why this spectrum is so important is its physical characteristics: an exceptionally attractive combination of capacity (bandwidth) and coverage (signals travel further and penetrate buildings more readily). This, in turn, means that it can be used for a very wide range of potential new services. These include additional television services delivered through DTT (whether in standard definition—SD—or HD), local television, new types of mobile broadband, mobile television, wireless home networks and many more.

1.12 This diversity of potential use makes the digital dividend exceptional in our spectrum awards programme.

Our objective

1.13 Our objective for the DDR is to maximise the total value to society that using the digital dividend generates over time. To this end, we have been rigorous in seeking to look at all potential sources of value. This includes the value that each of us derives as a consumer of new services. Critically, it also includes the value that communications services can create for society more widely through their potential for contributing to broad social goals like inclusion and promoting informed democracy.

1.14 This comprehensive approach meets our principal duty, which is to further the interests of citizens and consumers. It is also an approach we have applied consistently, so we have looked at citizen and consumer interests in relation to all the likely uses of the digital dividend, from mobile broadband to more DTT, mobile television and beyond.

1.15 Our work has already stretched over two years. It has included two major rounds of market research, using a variety of techniques to discover the opinions of citizens and consumers on the options for using this resource. It has also included extensive technical research and detailed economic analysis and modelling. Finally, it has included careful consideration of consultation responses and analysis of multiple policy options.

1.16 It is emphatically not our objective to award the digital dividend so as to maximise revenue for the Exchequer. Given our duties, this is not a consideration that we take into account.

1.17 In parallel with the DDR, our extensive work on public service broadcasting (PSB) has helped to identify potential threats to the delivery of public purposes in broadcasting in a timely way and contributed to a wider debate about potential solutions. These will be considered in our second PSB Review. And our ongoing work on access and inclusion is seeking to ensure citizens across the UK have access to services such as broadband Internet access and mobile telephony.

The strategic choice

1.18 The DDR consultation document, published on 19 December 2006,[1] said that we faced a strategic choice in the approach that we took to awarding the digital dividend. We summarised this as a choice between taking a market led approach and an interventionist one.

[1] www.ofcom.org.uk/consult/condocs/ddr/ddrmain.pdf.

1.19 Under a market led approach, we would release the spectrum in a way that would allow the widest possible range of technologies and services to be deployed. We would leave it to the market to decide how the spectrum should be used and create flexibility for users to change the use of spectrum over time, reflecting changes in technology and the preferences of citizens and consumers.

1.20 Under an interventionist approach, we would limit the way that the spectrum could be used through regulation. We would select particular uses or users, reserving spectrum for them and excluding others.

1.21 We noted that, historically, spectrum has been managed in a very interventionist way, with detailed regulation controlling who could use spectrum, for what and how. Spectrum policy has been used to pursue many different objectives, including the delivery of social policy goals, by gifting spectrum as an alternative to funding. But we observed that, as scarcity increased, spectrum management was changing around the world, with more emphasis on market mechanisms and flexibility for users and less resort to regulation.

1.22 We said that we had a clear presumption in favour of a market led approach and that this reflected our wider strategy for spectrum management: reducing regulation and making more use of market mechanisms. But we also recognised clearly the risk of market failure: the risk that markets might not deliver the best outcome for citizens and consumers in all circumstances.

1.23 We said that the key question for this phase of the DDR was whether intervening to control the use of the digital dividend was the best way of maximising total value to society. We set out a clear analytical framework for addressing this question, according to which we would consider both the potential benefits and the potential costs of intervening. And we identified two major types of cost: the opportunity cost created by displacing other uses and users and the long term effects of reducing flexibility in spectrum use and blunting incentives for efficiency.

1.24 We invited views on whether this was the right analytical approach, and we included an initial analysis of many arguments that had been put to us about the need to intervene.

1.25 In preparing this statement, we have again examined thoroughly the choices that we face and our analytical framework for assessing them. We conclude that the strategic choice we have identified remains valid and that the analytical framework we have used is robust.

1.26 We also think it is right to retain our presumption against intervening to limit the use of spectrum and in favour of a market led approach. In rapidly changing and converging markets, we think that the market is better placed than the regulator to determine the best uses of spectrum, including the digital dividend.

1.27 We have applied our analytical framework in detail to a wide range of potential uses and looked at many different options for intervening. We now turn to these.

The case for particular uses

1.28 Many stakeholders have suggested to us that we should ensure the digital dividend is used for particular uses or by particular users. Their proposals have included PSB in HD, local television, mobile television, wireless broadband in rural areas, public safety services, healthcare, education, community development, and providing new services for people with disabilities. We have also had many representations that we should protect the existing use of interleaved spectrum for PMSE, particularly wireless microphones.

1.29 The breadth of these proposals reflects the status of spectrum as a basic input into the economy, akin to capital or labour, which can be used in a vast array of ways in downstream products and services.

1.30 We have examined the case for intervening by looking at arguments common to several cases and considering in detail those potential uses that we think are most plausible.

1.31 Our analysis has identified two broad types of concern that are potential sources of market failure. These are:

- the costs of coordination. Some types of spectrum use involve large numbers of small users who act largely or wholly independently of each other. It can be very costly for these users to coordinate their demand for spectrum so that its value can be tested through market mechanisms against other uses and users; and

- the potential existence of broader social value. Some uses of spectrum can bring value to society (e.g. encouraging greater participation in civil society) that goes beyond what individual consumers might be willing to pay for a service.

1.32 We have also identified two points that are particularly relevant to the case for intervening on the grounds of broader social value:

- the need to look at all the possible ways of intervening and to consider whether allocating spectrum is the best mechanism; and

- the need to think about all the possible ways of delivering this value, including not just the digital dividend but other spectrum bands and wireless services and the whole range of wired communications.

1.33 Our conclusions are set out below. We deal first with the scope for authorising use of the digital dividend on a licence exempt basis, which avoids the need for individual licences, and then with possible licensed uses.

1.34 **We propose to allow licence exempt use of interleaved spectrum for cognitive devices.** Some licence exempt uses are able to coexist successfully with higher power licensed uses. Cognitive radio is a new technology that can detect spectrum that is otherwise unused and transmit without causing harmful interference. It has the potential to support a wide range of uses, including high speed always on broadband. It is particularly suited to operating in interleaved spectrum, where significant capacity is often unused at any one location at least some of the time.

1.35 We see significant scope for cognitive equipment using interleaved spectrum to emerge and to benefit from international economies of scale. But use of equipment in the UK will need to protect licensed users of this spectrum, including DTT and PMSE, against harmful interference. We will not allow cognitive equipment to use interleaved spectrum until we are satisfied on this point.

1.36 We think that allowing licence exempt cognitive use of interleaved spectrum is likely to be justified. Allowing access in this way will overcome the coordination problem they would otherwise face while imposing limited costs on other potential uses. We also think it is likely to encourage more innovation and competition in the provision of services, promoting the interests of citizens and consumers.

1.37 **We have decided not to set aside any of the digital dividend exclusively for licence exempt use.** The opportunity cost of setting aside spectrum just for licence exempt use would be high, and the additional benefits would be limited given the prospects for cognitive access to interleaved spectrum and the fact that large amounts of spectrum are already available for licence exempt use in other bands.

1.38 **We have decided not to hold back spectrum as an innovation reserve**. We have considered this idea carefully since the consultation but concluded that the arguments against it are strong.

1.39 Holding spectrum back would impose large costs on citizens and consumers now by reducing the availability of new services. It would also not be a good way of promoting innovation, not least as there would be significant uncertainty over when we should make the spectrum in the reserve available. It would only be beneficial if a high value use of the digital dividend emerged after the award and could not access the spectrum. This is not impossible, but we think it unlikely, not least given that our proposals for cognitive access to interleaved spectrum and allowing licensees to trade spectrum and change its use minimise this risk.

1.40 We see technological change in this area as continuous and indefinite. We do not think there will be a “eureka” moment at which the right future use of spectrum will become clear. We think the best way of promoting innovation is to award spectrum, not reserve it, and to pay particular attention to doing so in a way that will encourage new entry and new uses.

1.41 **We have decided to reserve most of the available interleaved spectrum to meet the needs of PMSE users.** PMSE is an existing use of interleaved spectrum. It comprises a large and diverse community of businesses, community organisations and individuals. We think that PMSE users would find it difficult to coordinate a bid for access to spectrum, and we think there is a high risk of market failure as result. However, with a careful transition, they can move to accessing spectrum via market mechanisms in the future.

1.42 We will award a single package of interleaved spectrum to a licensee that will act as a band manager. To help PMSE users with the transition to market mechanisms, we will use criteria designed to ensure that the band manager’s interests are aligned with those of PMSE users. The band manager will pay a charge for the spectrum based on Administered Incentive Pricing (AIP) and will be able to earn revenue by charging its customers for access. But regulation will ensure that it has to meet reasonable demand from PMSE users on fair, reasonable and non-discriminatory terms. So long as these obligations are met, the band manager will be able to allow others to make use of its spectrum.

1.43 **We have decided that channel 69 should continue to be available for PMSE use throughout the UK on a licensed basis.** We will also promote greater licence exempt use of channel 70 for PMSE, in the interests of community users.

1.44 These decisions close the separate PMSE consultation that we launched in June 2007. Shortly we will also publish detailed information on the availability of interleaved spectrum for PMSE after DSO.

1.45 **We have decided to award geographic packages of interleaved spectrum suitable for local television, but we will not restrict their use to this service.** We have found some interest in the use of the digital dividend for local television among viewers (through our market research[2]) and potential operators. But we think that if we release only UK wide packages of interleaved spectrum, local television operators would find it difficult to coordinate a bid. We will respond to the demand that we have identified by packaging some spectrum in geographic lots, based on main transmitter sites serving major towns and cities and areas where local television operators are already providing an analogue service.

1.46 We have identified around 25 possible locations across the UK where there is enough evidence of demand to justify offering such packages. We will be willing to consider other locations if there is persuasive evidence of demand. We will offer one or two packages in each location. Each package should allow, for example, the operation of a low power DTT multiplex carrying several SD channels.

1.47 We have considered arguments made by some local television operators and community media organisations for intervening more extensively, to reserve spectrum exclusively for local television and to award it by beauty contest. We have concluded that further intervention is not justified. It would have a high opportunity cost, displacing other potential users who could also generate high value for society. It would not ensure that local television is economically viable, and it would reduce incentives to use spectrum efficiently. We also think that other delivery mechanisms, such as broadband, might be an attractive alternative for delivering social goals.

1.48 These geographic packages of interleaved spectrum will be auctioned. We plan to begin with the first regions where DSO will take place: Border, Granada, West Country and Wales. We aim to hold the first awards by the end of 2008.

1.49 **We have decided not to reserve spectrum to provide more DTT services in SD.** The Government reserved almost 70% of the spectrum released by ceasing analogue television for DTT in 2003, before Ofcom took on its responsibilities. A number of stakeholders have pressed us to allocate more spectrum to DTT so that additional capacity will be available for SD services. Some service providers with public policy goals (e.g. Teachers TV, the Community Channel and NHS Direct) have linked this to the difficulty they face in accessing the capacity they would like on DTT multiplexes.

1.50 We recognise that a number of broadcast services, not just PSB delivered by organisations like the BBC, can deliver important public goals. We do not, however, think that allocating additional spectrum is an appropriate response to the issue identified. This is because it would displace other uses and users of the spectrum, including new uses that might be more innovative than additional SD services. This could impose a high cost on society. This is particularly so given that new technologies are likely to increase the capacity of the existing DTT multiplexes and hence allow more services to be provided without using additional spectrum that is in high demand for other uses. We also think that intervening in spectrum allocation is not the right way to address difficulties organisations like these may face in accessing multiplex capacity. This is first and foremost a matter of funding and choices about the best way to reach audiences.

1.51 We will, however, consider the role that services like these can play in delivering broader social value in our second PSB Review.

[2] www.ofcom.org.uk/radiocomms/ddr/documents/research07.

1.52 **We have decided not to reserve spectrum for DTT services in HD.** Many organisations and individuals pressed us during the consultation to set aside much or all of the digital dividend to provide DTT services in HD. They argued that, unless we intervened by reserving spectrum, PSB services would not be available in HD on DTT. They said that this would lead to a decline in the value and competitiveness of DTT and that this, in turn, would undermine the future of PSB.

1.53 The DDR consultation document observed that enough capacity would be available on the DTT platform at DSO to offer HD services without needing extra spectrum and that this could be done without having to reduce the number of other services available. Our confidence in this view has grown over the past year. We published detailed proposals on 21 November 2007 for upgrading the DTT platform to introduce new technologies on one of the six multiplexes.[3] This will allow HD services to be offered as DSO is rolled out, starting in the Granada region in late 2009 or early 2010—substantially earlier than would have been possible using the digital dividend.

1.54 Given that there are several options for offering HD services using the 256 MHz of spectrum already reserved for DTT, we do not consider that there is a case for allocating more spectrum to achieve the same goal.

1.55 **We have decided not to reserve any of the digital dividend for other services, such as mobile broadband and mobile television. But we will package the spectrum in a way that enables the widest possible range of uses, including additional DTT multiplexes as well as new mobile services.**

1.56 We think that mobile broadband could generate significant value for citizens and consumers, but we do not see a case for reserving any spectrum exclusively for this use or for other applications like mobile television.

1.57 We will, however, package cleared spectrum to enable the widest possible range of uses, in particular to meet potential demand for spectrum for additional DTT multiplexes, for mobile broadband and for mobile television. We regard these as likely uses of cleared spectrum. We have seen evidence of interest from both citizens and consumers (through our market research) and from potential service providers.

1.58 We also propose to offer a package of interleaved spectrum in a way that could enable a wide range of new uses, including mobile broadband or extra DTT. This would comprise channels 61 and 62, which are adjacent to the upper cleared spectrum.

Award process and timing

1.59 **We have decided to auction cleared spectrum.** This reflects our view that an auction is the fairest and most transparent way to award rights to use spectrum and that it is superior to a beauty contest. We think that market mechanisms are the most effective tool available to encourage efficient use of spectrum and should be used unless there is a compelling case to the contrary.

1.60 **We have decided to auction channel 36 alongside cleared spectrum.** Channel 36 is different because it is currently used for ground based aeronautical radar, a use that will cease at the end of March 2009. Channel 36 will therefore be available UK wide before other cleared spectrum, which will only be fully vacated when DSO ends in 2012. We will allow early use of channel 36 that does not materially degrade

[3] www.ofcom.org.uk/consult/condocs/dttfuture/dttfuture.pdf.

analogue television services operating in adjacent channels. We have also considered whether to award channel 36 before the rest of the digital dividend, but there are many options for using this spectrum that would involve combining channel 36 with other frequencies. Auctioning channel 36 separately could impose very large costs by making it difficult to realise these options. We also see few advantages to a separate auction, which would, at best, advance the award by a few months.

1.61 **We have decided to auction the packages of interleaved spectrum, except for the package with PMSE obligations, which we will award by beauty contest.** We have concluded that, in this latter case, an auction would not be appropriate. Qualitative criteria—notably the technical and managerial ability to meet the needs of PMSE users—will be required to select the band manager, and the intervention required to allow these users to move to a market led approach to spectrum access reduces the benefit of an auction. We recognise that this level of intervention in the use of interleaved spectrum creates risks to the long term efficiency with which it is used. We will mitigate these by charging the band manager AIP, creating an incentive to use the spectrum more efficiently.

1.62 **We have decided to award the digital dividend as soon as possible.** This will allow citizens and consumers to benefit from new services with minimum delay. We consider that the auction of cleared spectrum could be held in the first half of 2009 but that some of the geographic packages of interleaved spectrum suitable for local television and the package with PMSE obligations could be awarded by the end of 2008.

Issues for further consultation

1.63 The approach set out above will create new opportunities for the UK communications sector to bring an array of new products and services to citizens and consumers, to deploy new technologies and to create new ways of generating and delivering value.

1.64 The significance of this opportunity is immense. Our analysis suggests that the value to citizens and consumers generated by using the digital dividend could be £5-10 billion (net present value—NPV—over the next 20 years). This is not an estimate of auction proceeds.

1.65 But there is a great deal more to be done to turn these opportunities into reality. This statement concludes the first phase of the DDR by making decisions on the strategic choice that we identified last year. There is another, equally important phase to come: the detailed design of the awards and the terms of the licences awarded.

1.66 During this phase, we will consider in detail how awarding this spectrum can best promote competition and innovation in downstream markets and guard against the possibility of anticompetitive behaviour such as hoarding.

1.67 Our experience of spectrum awards suggests that a well designed auction can be a powerful tool for encouraging new entry, new services and new technologies. We will harness experience of spectrum markets around the world to address issues such as the packaging of the spectrum, the options for auction design, the contents of licence conditions and the need for specific measures to protect and promote competition.

International developments

1.68 Spectrum management in the UK takes place within international frameworks set both globally and in the European Union (EU). Two recent developments are particularly relevant to the DDR.

1.69 First, the World Radiocommunication Conference 2007 (WRC-07) agreed to change the international Radiocommunication Regulations to make spectrum currently used for analogue television more flexible, in particular enabling mobile use.

1.70 This has limited direct effect on the UK because agreements with other European countries already give us substantial flexibility. But the indirect benefits of the agreement could be large, opening up the prospect that many more countries will make a digital dividend available for new wireless services. This will help to create global economies of scale for equipment, so reducing prices for UK consumers.

1.71 Second, the European Commission has published a Communication on a common approach to the digital dividend in the EU. This recommends identifying common bands that can be optimised by enabling “clusters” of services using a similar type of communications network: broadcasting, mobile multimedia and mobile broadband. These bands would be planned and harmonised in some form at EU level.

1.72 We recognise that the UK will benefit if other EU Member States release a digital dividend, particularly if they do so in a broadly similar way. But requiring them to replan the frequencies they are using to deliver DSO would significantly delay this process. Discussions in the EU also need to be concluded quickly so that citizens and consumers can benefit from new services as soon as possible.

1.73 We therefore strongly support a non-mandatory approach to harmonising the digital dividend in the EU. This will allow Member States to participate to the extent that they wish while not favouring one use of the digital dividend over others.

1.74 We will contribute fully to EU discussions in the months to come. In the meantime, we believe it right to press ahead with the DDR in the interests of bringing benefits to UK citizens and consumers at the earliest possible date.

Next steps

1.75 We will consult on the detailed design of the digital dividend awards in spring 2008.

1.76 In relation to cleared spectrum and interleaved channels 61 and 62, we hope to publish the information memorandum and auction rules by the end of 2008. The auction itself could take place in the first half of 2009.

1.77 In relation to interleaved spectrum, we expect to auction geographic packages in the Border, Granada, West Country and Wales regions by the end of 2008. We expect to award the package with PMSE obligations by beauty contest to the same timetable. Auctions of the remaining geographic packages will follow in 2009.

1.78 This timetable is subject to factors outside our control, particularly developments in the EU, and may change during the course of the rest of the DDR.

Section 2

Introduction

Background

2.1 Around Europe and the rest of the world, television broadcasting is embracing the digital age. New emerging broadcast technologies and standards mean that the pace of change is increasing rapidly. In the UK, for example, the number of households watching digital television in June 2007 was 85%, compared with 66% two years earlier.[4] There are now several digital broadcasting platforms available in the UK: satellite, cable, television over broadband and DTT.

2.2 In the UK, the Government has decided that analogue television should cease by 2012. This will allow the expansion of DTT to cover as much of the country as analogue covers now. This programme of change—DSO—will have two major consequences. First, there will be an expansion of the number and range of services available via terrestrial television across the UK. Second, a large amount of spectrum—the digital dividend—will become available for new uses.

2.3 This is possible because digital technology is more efficient than analogue, carrying much more content in a given amount of spectrum. The move from analogue to digital broadcasting therefore has important consequences for spectrum, which is a scarce resource of great importance to our economy and society.

2.4 As well as being one of the fundamental inputs for terrestrial broadcasting, spectrum supports a wide range of different communications services. Access to spectrum is key to innovation and competition in the fast growing information and communications technology (ICT) sector in addition to a wide range of applications in other fields, including defence, transport and science. Wireless technology is increasing in importance given rising demand for communications and entertainment while on the move. The use of spectrum underpins 3% of the UK's GDP and generates benefits worth over £40bn a year, a figure that has grown by about a half in real terms since 2002.[5] Indeed, this is likely to be an underestimate as it does not take into account the use of spectrum for commercial aviation, public safety, defence or science or directly assess the impact of high levels of innovation associated with many uses of spectrum.

2.5 This statement sets out our approach to awarding the digital dividend. This is the largest amount of the most valuable spectrum that is likely to be available in the UK for the foreseeable future.

Terrestrial broadcasting in the UK

2.6 The spectrum generally regarded as being of most value in the UK lies between 200 MHz and 1 GHz. This spectrum is in high demand due to its attractive characteristics. At these frequencies, signals generally propagate well, which means that large areas can be covered at relatively low cost and signals tend to penetrate buildings easily. At the same time, there is sufficient spectrum available for services that require large capacity or bandwidth. This combination of characteristics makes it suitable for the widest range of applications.

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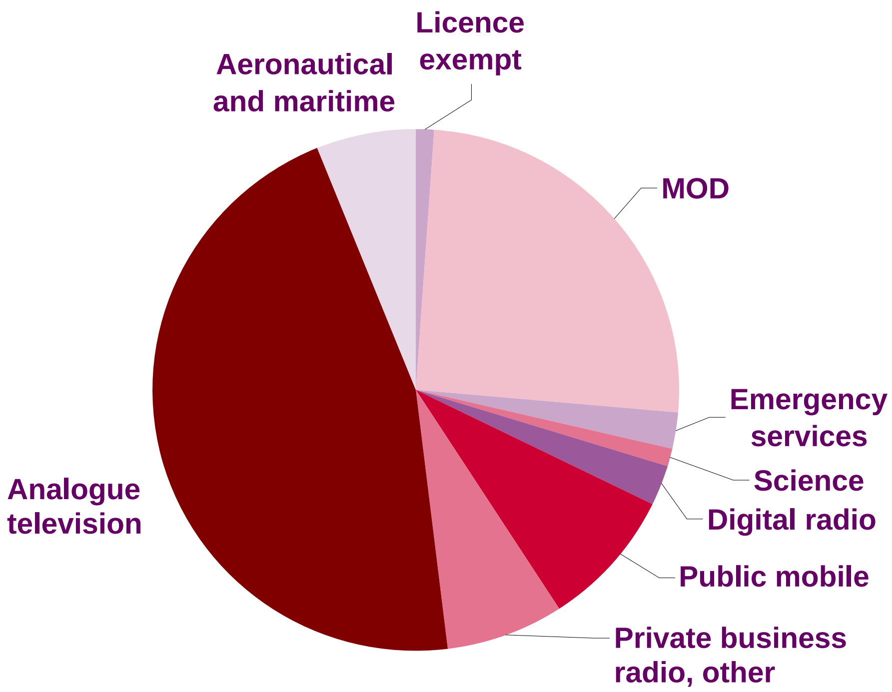
4 www.ofcom.org.uk/research/cm/cmr07/cm07_print/.
5 www.ofcom.org.uk/research/radiocomms/reports/economic_spectrum_use/economic_impact.pdf.

2.7 Figure 1 shows that analogue television is currently the largest single use of this spectrum. It occupies 368 MHz of spectrum between 470 and 862 MHz (Ultra High Frequency—UHF—bands IV and V) and 46% of the total spectrum between 200 MHz and 1 GHz. This capacity is used principally to carry the five main analogue channels, according to a plan largely dating back to 1961. Existing DTT services and some other secondary uses fit in and around this analogue plan. Mobile telecommunications, by contrast, uses only about 70 MHz, less than 9% of the total.

Figure 1. Existing use of spectrum between 200 MHz and 1 GHz



DSO

2.8 On 15 September 2005, the Secretary of State for Culture, Media and Sport confirmed that the UK's analogue television signals would be switched off region by region between 2008 and 2012.[6] Switching off the analogue signal will allow a reorganisation of all 368 MHz currently used by terrestrial television.

2.9 In principle, there exists a wide range of choices about the use of this capacity. For example, the five main analogue television services could be carried on just one DTT multiplex, requiring only 40 MHz. However, important decisions have already been made about the use of most of the spectrum. In particular, the Government decided in 2003 that, at DSO, 256 MHz—more than two thirds—should be assigned to the operators of the six DTT multiplexes operating before DSO.[7]

2.10 A substantial amount of spectrum will still become available for new uses following DSO. The Government's decision provided for this digital dividend. It stated that at least 14 frequency channels—each of 8 MHz, making a total of 112 MHz—would be cleared across the UK. It also noted that spare capacity available in spectrum interleaved with the six DTT multiplexes could be used for additional services and that services such as wireless microphones currently made use of this interleaved

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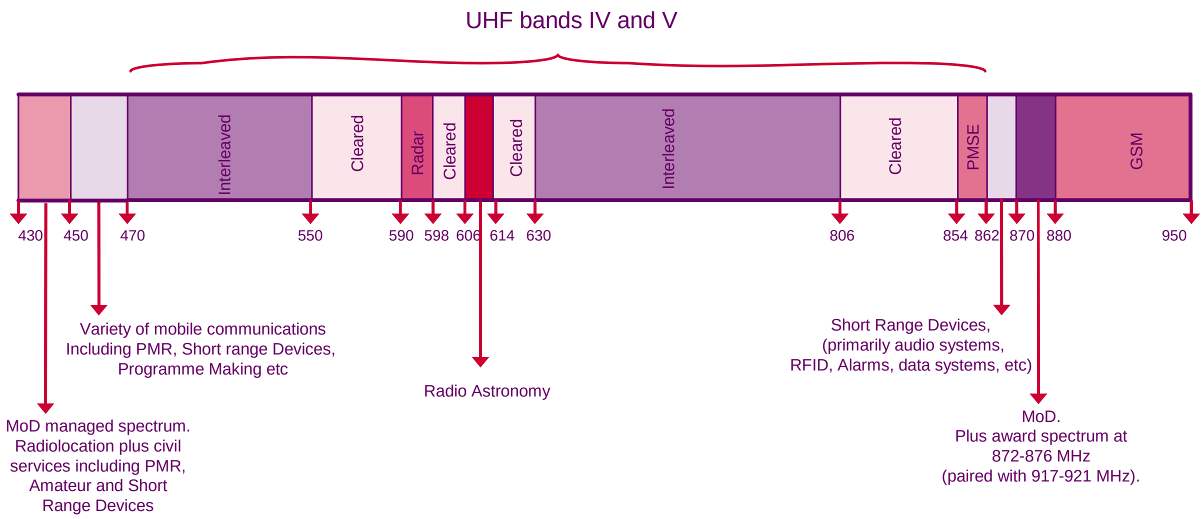
6 www.culture.gov.uk/Reference_library/Press_notices/archive_2005/dcms116_05.htm.
7 www.digitaltelevision.gov.uk/publications/pub_spectrum_planning.html.

spectrum. Cleared and interleaved spectrum are explained in more detail later in this section.

The digital dividend

2.11 Figure 2 shows the digital dividend in the context of adjacent spectrum use between 430 and 950 MHz. The principal use above 862 MHz is GSM mobile telecommunications. Smaller quantities of spectrum are used for short range licence exempt equipment and by the Ministry of Defence (MOD). MOD is the principal user below 470 MHz, for a variety of applications including radar. There is also some civil use, including extensive use by private mobile radio (PMR) at 450-470 MHz.

Figure 2. The digital dividend and adjacent spectrum use between 430 and 950 MHz



Different types of spectrum

2.12 Different types of spectrum are available for award as part of the digital dividend. The principal distinction that needs to be made is between cleared spectrum and interleaved spectrum.

Cleared spectrum

2.13 Cleared spectrum will be available for new uses on a UK wide basis. These channels are also used in neighbouring countries and are subject to incoming interference from them. Most of this spectrum will be freed as a direct consequence of DSO, which will release 112 MHz. In the existing plan for this spectrum, these channels are numbered 31-35, 37, 39-40 and 63-68.

2.14 This statement also sets out our approach to other channels in UHF bands IV and V that have potential to be cleared on a similar timeframe, namely channels 36 (currently used for aeronautical radar) and 69 (currently used for PMSE). Channel 38 is mainly used for radioastronomy, and we have no plans to require this use to cease.

Interleaved spectrum

2.15 The digital dividend also includes the interleaved capacity that will be available within the 256 MHz reserved for the six DTT multiplexes. In any one location, only six channels are used for the preferred DTT service. It is the remaining channels that make up interleaved spectrum (also known as white space). In principle, these are available for alternative uses, although some channels will be required for transmitter relays and some locations are capable of receiving two or even three DTT services, each using a different set of six channels. The identity of these channels will change from location to location, and the extent to which they can be used will depend heavily on how they are used to carry DTT elsewhere. But in any given location, it can be a large amount of spectrum. Similar capacity but with a different pattern of frequency availability exists at present within the spectrum used for analogue television.

2.16 Figure 3 shows these different types of spectrum in the context of the wider use of UHF bands IV and V. It gives both channel numbers and the frequencies for each channel. For example, channel 21 occupies 470-478 MHz, while channel 36 occupies 590-598 MHz. For simplicity, this statement will generally refer to spectrum by channel number. Where appropriate, it will refer to both channel numbers and frequencies.

Figure 3. Channel numbers and frequencies for UHF bands IV and V

Channel	21	22	23	24	25	26	27	28	29	30	31	32
Frequency (MHz)	*470-478*	*478-486*	*486-494*	*494-502*	*502-510*	*510-518*	*518-526*	*526-534*	*534-542*	*542-550*	*550-558*	*558-566*
	33	34	35	36	37	38	39	40	41	42	43	44
	566-574	*574-582*	*582-590*	*590-598*	*598-606*	*606-614*	*614-622*	*622-630*	*630-638*	*638-646*	*646-654*	*654-662*
	45	46	47	48	49	50	51	52	53	54	55	56
	662-670	*670-678*	*678-686*	*686-694*	*694-702*	*702-710*	*710-718*	*718-726*	*726-734*	*726-742*	*742-750*	*750-758*
	57	58	59	60	61	62	63	64	65	66	67	68
	758-766	*766-774*	*774-782*	*782-790*	*790-798*	*798-806*	*806-814*	*814-822*	*822-830*	*830-838*	*838-846*	*846-854*
	69											
	854-862											

Cleared spectrum
Aeronautical radar
Programme-making and special events
Interleaved spectrum
Radioastronomy

Matters addressed by this statement

Our approach to awarding the digital dividend

2.17 In general, we prefer a market led approach to awarding spectrum, allowing users flexibility to determine how it is used. This is the position set out in our Spectrum Framework Review (SFR),[8] and it is the approach we have taken to the rest of our spectrum awards programme.

2.18 The wide range of potential uses for the digital dividend distinguishes it from other awards. Potential uses that we have identified or that have been suggested to us include:

- mobile television and other types of mobile video and multimedia;
- extending existing DTT coverage;

[8] www.ofcom.org.uk/consult/condocs/sfr/sfr2/sfr.pdf.

- new DTT channels aimed at a UK market in either SD or HD;
- new DTT channels aimed at local markets (i.e. local television);
- wireless microphones and applications for PMSE;
- other low power applications, like hubs to distribute content around the home or using ultra wideband (UWB) technologies;
- broadband wireless applications, which could be mobile, and other mobile voice and data services;
- services using satellite communications;
- emergency and public safety services;
- cognitive radio;
- community radio;
- digital radio;
- communication with medical professionals and educational institutions;
- amateur and/or university use;
- new services for people with disabilities;
- international and cross border uses (e.g. an international emergency channel);
- digital public service teletext to match the analogue service; and
- user created networks (e.g. employing mesh technology).

2.19 This list is not exhaustive, and rapid changes in technologies, services and applications in the communications sector mean that new uses of the digital dividend will continue to emerge.

2.20 Given this wide range of potential uses, we have to consider carefully our objective for awarding the digital dividend in the light of our duties and whether the best way to meet that objective is to pursue a market led approach or whether we need to intervene. This assessment is particularly important given that many of the potential uses might deliver broader social value as well as value to consumers and producers.

2.21 Where we identify that a market led approach will not meet our objective, we consider that the market will fail. Therefore, in the context of the DDR, we define a market failure to be when:

> a well designed auction of rights to spectrum that is subject to only the minimum constraints on use would not achieve an efficient outcome—that is to say, the holding and exploitation of spectrum by the users and for the uses that generate maximum value for society over time.

2.22 To inform our market failure assessment, we have constructed a framework to analyse the services that we believe are most likely to use the digital dividend and the potential sources of value that these services could bring to citizens and consumers. We have called this a total value framework. Applying this framework helps us to assess whether there are significant risks that a market led approach to awarding the digital dividend would not meet our objective (i.e. market failure would occur) and, if so, whether total value would be higher if we intervened to control the future use of this spectrum.

The decisions we have made

2.23 The fundamental question for this statement is whether we should take a market led approach to awarding the digital dividend or adopt an interventionist approach. We consulted on this and other issues addressed in this statement between 19 December 2006 and 20 March 2007.

2.24 Our proposals generated over 750 responses, among the highest number to a consultation we have ever received. We published a summary of these on 29 May 2007.[9]

2.25 We have decided that a market led approach to awarding the digital dividend is generally most likely to meet our objective. However, in relation to PMSE use of this spectrum, we believe that intervention is justified. We have therefore decided to award a package of this spectrum to a band manager via beauty contest with obligations safeguarding its continued use by this sector.

2.26 We have also identified a risk of coordination problems preventing local television operators from bidding effectively for spectrum. As a consequence, we have decided to auction geographic packages of interleaved spectrum in specific locations that match the pattern of demand for local television. These packages will be suitable but not reserved for use by local television.

2.27 Other key decisions that we have taken are:

- to propose to allow access to interleaved spectrum by cognitive radio on a licence exempt basis;
- not to set cleared spectrum aside for licence exempt use or as an innovation reserve; and
- not to award channel 36 ahead of cleared spectrum but to allow access as soon as its current use is cleared.

Issues on which we will consult in the spring

2.28 We have not made decisions about most aspects of detailed award design. This includes technical constraints, usage rights and obligations, packaging and competition issues as well as the implications of major forthcoming events (e.g. the London Olympics and the Glasgow Commonwealth Games) and the position of the Crown Dependencies. We will consult on these issues in spring 2008.

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[9] www.ofcom.org.uk/radiocomms/ddr/condocsummary/ddrsummary.pdf.

Structure of this statement

2.29 This statement is structured as follows:

- section 3 looks at relevant developments in the EU and the rest of the world and at WRC-07 and considers their implications for the DDR;
- section 4 sets out how we have interpreted our relevant duties in formulating our spectrum management strategy in general and our objective for the DDR in particular. It also explains the total value framework that we have used to help us evaluate whether we are meeting that objective;
- section 5 considers how we should go about answering the strategic question of whether following a market led approach to award the digital dividend will meet our objective for the DDR or whether we should depart from this by intervening to determine how the spectrum is used (i.e. an interventionist approach) in order to maximise total value;
- section 6 considers the extent to which we should make the digital dividend available by licence exemption rather than by licensing specific rights of use. It also considers whether we should hold back some of the spectrum as an innovation reserve;
- section 7 considers whether a market led approach to awarding the digital dividend is likely to lead to market failure for likely licensed uses. It explains our sources of evidence, including the results of expanded and updated market research. It then considers the merits of intervention for each likely licensed use;
- section 8 sets out our decisions on implementing the digital dividend awards, in particular the mechanisms for releasing the spectrum;
- section 9 sets out our position on the timing of the digital dividend awards;
- section 10 considers other issues on which we will consult further; and
- section 11 sets out the next steps in the DDR.

2.30 The annexes to this statement often repeat points made in the statement itself. This is not only unavoidable but to some extent desirable given that similar issues were raised in response to a number of different questions. We have also sought, where possible, to provide a comprehensive and accessible account of our analysis.

Section 3

International developments

Introduction and summary

3.1 There are important international dimensions to the use of spectrum. This section looks at relevant developments in the EU and the rest of the world and at WRC-07 and considers their implications for the DDR. It concludes that we will continue to engage at all levels to promote market led harmonisation.

The EU

Regulatory framework for electronic communications

3.2 The EU has important powers and responsibilities regarding spectrum management. At a general level, it provides a regulatory framework for electronic communications, including provisions on the use of spectrum. This framework is set out in detail in legislation that was adopted by the European Parliament and the Council of Ministers in 2002.[10] This was incorporated into UK law by the Communications Act.[11] Annex 6 contains a more detailed discussion of our obligations relevant to spectrum management under this framework.

3.3 Under the Radio Spectrum Decision,[12] the Commission can adopt Decisions governing spectrum use. This can be done in the interests of ensuring effective policy coordination and, where appropriate, harmonised conditions for spectrum use in the internal market. These Decisions are binding on Member States and can only be adopted by the Commission with the support of a qualified majority of them, convened as the Radio Spectrum Committee (RSC). We represent the UK at RSC under direction by the Government.

3.4 The Radio Spectrum Policy Group (RSPG) works in parallel with RSC and also draws its membership from Member States. Again, we represent the UK under direction by the Government. RSPG's role is to give strategic advice to the Commission on major questions of spectrum policy. It does this by adopting Opinions, which are not binding but can have significant influence as they represent the prevailing view of Member States. RSPG Opinions adopted thus far that are relevant to the digital dividend include:

- Opinion on wireless access policy for electronic communications services (WAPECS) (a more flexible spectrum management approach).[13] Adopted on 23 November 2005, this proposes the use of the WAPECS concept—technology and service neutrality and authorisation conditions that do not distort competition, with the aim of ensuring the effective and efficient use of spectrum—to facilitate the provision of converged services and to foster innovation and growth;

- Opinion on the introduction of multimedia services in particular in the frequency bands allocated to the broadcasting services.[14] Adopted on 25 October 2006, this

[10] http://ec.europa.eu/information_society/policy/ecomm/current/index_en.htm.
[11] www.opsi.gov.uk/acts/acts2003/pdf/ukpga_20030021_en.pdf.
[12] http://eur-lex.europa.eu/LexUriServ/site/en/oj/2002/l_108/l_10820020424en00010006.pdf.
[13] http://rspg.groups.eu.int/doc/documents/opinions/rspg05_102_op_wapecs.pdf.
[14] http://rspg.groups.eu.int/doc/documents/opinions/rspg06_143_final_rspg_opinion_multimedia_services.pdf.

addresses licensing, limiting constraints and obligations to the minimum necessary, the suitability of several spectrum bands and several actions that could be considered at a European level to facilitate the introduction of multimedia services within Europe; and

- Opinion on EU spectrum policy implications of the digital dividend.[15] Adopted on 14 February 2007, this addresses the possibility for harmonising parts of the digital dividend in Europe, points out various difficulties and calls for a mandate to be given to the European Conference of Postal and Telecommunications Administrations (CEPT) to study the issue.

3.5 The Communications Committee (COCOM) assists the Commission in carrying out its executive powers and provides a platform for information exchange on market developments and regulatory activities. Member States must take utmost account of Commission Recommendations that have been endorsed by COCOM. One Recommendation that it is considering relates to authorisation conditions for six WAPECS bands, including UHF bands IV and V. UK representation is led by the Department for Business, Enterprise and Regulatory Reform.

The EU framework review

3.6 On 13 November 2007, the Commission published proposals to amend the legislation defining the EU regulatory framework.[16] Reforming spectrum management to increase flexibility and greater use of market mechanisms is a central plank of the proposals. The Commission intends that service and technology neutrality should be the norm, with exceptions to avoid harmful interference, protect public health, ensure sharing of spectrum or meet general interest objectives. Member States would be required to permit spectrum trading in certain bands identified by the Commission, with the ability to introduce trading more widely if they so wished. And the Commission proposed that pan-European authorisations to use spectrum be considered by a new European Electronic Communications Market Authority.

Commission Communication on the digital dividend

3.7 On 13 November 2007, the Commission also published a Communication on a common approach to the use of the digital dividend in the EU.[17] It invites Member States to facilitate the introduction of new services by working together and with the Commission to identify common spectrum bands in the digital dividend that can be optimised by creating “clusters” of services using a similar type of communications network:

- unidirectional high power networks (i.e. mainly for fixed broadcasting services). This spectrum would be subject to national management;

- unidirectional medium to low power networks (i.e. typically for mobile multimedia services and newer forms of converged broadcasting and communications services). This spectrum would be subject to national management, combined with optional EU coordination; and

[15] http://rspg.groups.eu.int/doc/documents/opinions/rspg07_161_final_op_digdiv.pdf.
[16] http://ec.europa.eu/information_society/policy/ecomm/tomorrow/index_en.htm.
[17] http://ec.europa.eu/information_society/policy/ecomm/doc/library/proposals/com_dd_en.pdf.

- bidirectional low power networks (i.e. typically for fixed and mobile broadband access services). This spectrum would be subject to EU harmonisation on a flexible basis.

3.8 The Communication concludes by indicating that the Commission will prepare the required measures to reserve and coordinate the common bands at EU level. Our award of the digital dividend and the future use of this spectrum will need to comply with any mandatory EU measures.

3.9 We welcome the opportunity to debate this very important issue at European level, including consideration of the benefits that a common approach to the use of this spectrum could bring. However, we believe that three key issues must be taken into account if these benefits are to be maximised:

- discussions in the EU about pan-European measures need to be concluded quickly—more quickly than consideration of the Commission's framework review proposals. This will ensure that European citizens and consumers can benefit from new, innovative and competitive services worth billions of euros—including those that the Commission has said are desirable for supporting its i2010 strategy[18]—as quickly as possible;

- Member States should not have to replan the specific frequencies they are using to introduce DTT. These were agreed across International Telecommunication Union (ITU) Region 1—Europe, the Middle East and Africa—in Geneva in 2006 after substantial negotiation. A major replan of the Geneva 2006 Agreement (GE-06) would seriously threaten DSO in Member States; and

- Member States are at very different stages of DSO and have very different digital dividends. Given this, it will be extremely difficult, if not impossible, to mandate a common solution for the whole of the EU. Any such measure would be inconsistent with GE-06 and seriously disrupt plans for DSO in many Member States. We therefore strongly support a non-mandatory and non-exclusive approach, allowing Member States to participate to the extent that they wish while not favouring any one service over another. This could encourage and facilitate greater cooperation and consistency over time.

3.10 The technical detail in the Communication and the identification of common bands is based on work undertaken by Task Group 4 (TG4) within CEPT. TG4 operates under a mandate from the Commission to study technical considerations regarding harmonisation options for the digital dividend. TG4 is due to submit its final report to the Commission around the end of 2007. This will be discussed by RSC in 2008.

3.11 The key conclusions culminating from TG4's work are that:

- harmonising a sub-band in a way that enables two way mobile applications (including uplinks) is feasible from a technical, regulatory and administrative point of view provided that it is not made mandatory or exclusive; and

- the preferred sub-band is the upper part of UHF bands IV and V and should include, as a minimum, channels 62-69 (798-862 MHz). We note that while channels 63-68 are cleared spectrum in the UK's digital dividend, channels 62 and 69 are not. Section 8 sets out our decisions on implementing the award of these channels.

[18] http://ec.europa.eu/information_society/eeurope/i2010/index_en.htm.

3.12 Annex 7 contains further details about TG4 and the work supporting its conclusions.

The rest of the world

Europe

3.13 In some European countries—including Belgium, the Czech Republic, Italy and Spain—little or no digital dividend has been identified. These countries do not currently plan to use UHF bands IV and V for services other than broadcasting (both DTT and mobile television).

3.14 Other countries have recognised the value of this spectrum for non-broadcasting applications and are considering how to use and release any digital dividend. Finland's Government established a national working group in March 2006 to prepare proposals for doing so. French telecommunications regulator ARCEP publicly consulted in July 2007 seeking views on the use of the digital dividend in France and highlighting the need to make a sub-band of UHF bands IV and V (as identified by TG4) available for mobile uses.[19] Sweden's Infrastructure Minister commented on 6 November 2007 that the key issue was how much spectrum should go to television and how much could be used for mobile services such as mobile broadband.[20]

United States

3.15 In the US, analogue television will cease on 17 February 2009. A mix of legislative and regulatory action has released a digital dividend of 108 MHz in the 700 MHz band. 24 MHz of this has been set aside for public safety, and 22 MHz has already been auctioned to allow new commercial uses such as mobile television.

3.16 The Federal Communications Commission (FCC) will auction the remaining 62 MHz for a mixture of commercial and public safety services, beginning on 24 January 2008.[21] While this band does not align directly with cleared spectrum in the UK's digital dividend, it is sufficiently close to create economies of scale for equipment designed to operate in both the UK and US markets.

Other countries

3.17 DSO in Japan will release the 48 MHz between 722 and 770 MHz. The release of 12 MHz between 710 and 722 MHz is also being considered. This spectrum may be awarded by technology neutral auctions. DSO in Korea will free up the 54 MHz between 752 and 806 MHz. The future use of this spectrum has yet to be decided.

3.18 Some countries, including Australia and South Africa, have expressed interest in realising a digital dividend but have not yet identified how much spectrum, if any, will be released. Others, including Brazil, China, India and New Zealand, are still at an early stage in planning DSO.

WRC-07

3.19 Global coordination of spectrum use is undertaken within the ITU, a United Nations agency with a mission to maintain and extend international cooperation for the improvement and efficient use of telecommunications of all kinds. The ITU holds a

[19] www.arcep.fr/uploads/tx_gspublication/consult-divid-num-130707-eng.pdf.
[20] www.thelocal.se/9022/20071106.
[21] http://wireless.fcc.gov/auctions/default.htm?job=auction_factsheet&id=73.

World Radiocommunication Conference every three to four years to review and, if necessary, amend the Radiocommunication Regulations—an international treaty governing how spectrum is shared globally—to reflect the changing needs of various wireless services and applications. WRC-07 took place from 22 October to 16 November 2007.

3.20 WRC-07 considered providing for future mobile systems, known in the ITU as International Mobile Telecommunications (IMT). It considered several proposals to add a primary mobile allocation to UHF bands IV and V, with a non-exclusive identification for IMT. The outcome included a primary mobile allocation in Region 1 for 790-862 MHz (channels 61-69). This comes into effect from 17 June 2015.

3.21 WRC-07 also extended existing provisions of the International Frequency Table to IMT in this band for the period up to 2015 for a number of countries, including the UK. Table 1 summarises the overall result.

Table 1. Timeline of ITU mobile allocation in the band 790-862 MHz

Now	Footnote 5.316: primary mobile allocation for various countries including the UK, the Netherlands, and France (830-862 MHz only). Lesser status with respect to other countries.
1 January 2009	Footnote 5.316A: extension of provisions to many more Region 1 countries but not Belgium or Ireland.
17 June 2015	Primary mobile allocation in Region 1 subject to the application of procedures from GE-06.

3.22 Because European signatories to GE-06 have agreed that assignments for DTT can be used for other services as long as they cause no greater interference, we already had flexibility to enable mobile use of the digital dividend in the UK before WRC-07. However, the focus of attention at WRC-07 and the identification of common bands in many countries should help to provide economies of scale that can drive down equipment costs and facilitate the take-up of new services, providing indirect benefits to the UK.

Conclusion

3.23 This section has considered developments relevant to the DDR:

- in the EU;
- in other countries; and
- at WRC-07.

3.24 We will continue to contribute to the work of TG4 and other technical bodies. We plan further work to establish licence conditions suitable for two way mobile applications as well as other uses, and we will study further the viability of two way mobile use of interleaved spectrum.

3.25 We will also engage fully and constructively in EU discussions about the digital dividend and explore how to promote market led harmonisation with other international bodies and stakeholders.

Section 4

Our duties and our objective for the DDR

Introduction and summary

4.1 This section sets out how we have interpreted our relevant duties in formulating our spectrum management strategy in general and our objective for the DDR in particular. It also explains the total value framework that we have used to help us evaluate whether we are meeting that objective.

Legal framework

4.2 We make decisions within a framework defined in EU and UK law. This sets out overarching general duties, which apply across all our functions, to further the interests of citizens in relation to communications matters and to further the interests of consumers in relevant markets, where appropriate by promoting competition. Below these general duties sit three broad groups of specific duties. One group relates to securing the optimal use of spectrum, a second to our responsibilities for broadcasting and a third to the provision of electronic communications services (ECS). A summary of these statutory duties can be found in annex 6.

4.3 Our task is to apply these duties in the DDR to determine how best to exercise our functions. Where our duties conflict with each other, the principles of good regulation guide us to take proportionate, transparent, evidence based and balanced decisions.

Applying our spectrum duties

4.4 Our spectrum duties focus on securing the optimal use of spectrum. Leaving spectrum unused will not fulfil this duty.

4.5 As in all cases where spectrum is available for award, it is highly relevant to look at potential uses of the digital dividend. Section 2 explained that the wide range of such uses sets this apart from other awards.

4.6 As discussed in more detail in this statement, we consider that this points to an approach to awarding the digital dividend that gives a wide variety of competing uses and users an equal opportunity for access both immediately and over time.

Applying our broadcasting duties

4.7 Our broadcasting duties include:

- securing the availability throughout the UK of a wide range of television and radio services which (taken as a whole) are both of high quality and calculated to appeal to a variety of tastes and interests; and
- having regard to the desirability of promoting the fulfilment of the purposes of public service television broadcasting in the UK.

4.8 We consider that, with the spectrum reserved for DTT and the availability of other spectrum and fixed networks, PSBs and commercial broadcasters have sufficient capacity to fulfil the first of these duties. We consider that the spectrum reserved for DTT (almost 70% of the amount used for analogue television) is sufficient to fulfil the second. We particularly note that this spectrum currently supports more than 40 SD services, many of which are PSB channels, as well as interactive and radio services. This represents a major increase in the range of content, and in the volume of content provided by PSBs, over the five services available via analogue television.

4.9 We recognise that PSB needs to continue evolving to achieve reach and impact in an all digital world. Our extensive work in this area (including our first PSB Review,[22] our review of children's programming,[23] our New News, Future News report[24] and our financial review of Channel 4[25]) has identified potential threats to the delivery of public purposes in broadcasting and contributed to a wider debate about potential solutions. At present, the evidence is insufficient to conclude that more PSB DTT services are necessarily the best way to achieve the goals of maintaining and strengthening the quality of PSB in future or that the PSBs are unduly disadvantaged in securing additional DTT capacity, even if that is the best option. This analysis is supported by the terms of reference for our second PSB Review, which argues that a much wider set of possible long term solutions for PSB should be considered.[26]

4.10 We therefore conclude that we do not need to intervene in the award of the digital dividend to favour certain users or uses in order to meet our broadcasting duties. Section 7 nonetheless takes into account the broader social value associated with different broadcasting services in applying our total value framework.

Applying our ECS duties

4.11 Our ECS duties include securing the availability throughout the UK of a wide range of ECS and having regard to the desirability of encouraging broadband availability and use throughout the UK.

4.12 We consider that there is already sufficient spectrum, in combination with fixed networks, to fulfil these duties. This is enhanced by our programme to extend the liberalisation and tradability of spectrum use and by a number of initiatives promoting increased broadband availability and use throughout the UK, both of which have grown.[27] Our ongoing work on access and inclusion is examining the extent of availability of ECS such as broadband Internet access and mobile telephony and looking at the options available for addressing any gaps identified. Finally, we note that the scope of universal service will be the subject of a Commission Communication in mid-2008.

4.13 We therefore conclude that we do not need to intervene in the award of the digital dividend to favour certain users or uses in order to meet our ECS duties. Section 7 nonetheless takes into account the broader social value associated with different ECS in applying our total value framework.

Our spectrum management strategy

4.14 Historically, regulators approached spectrum management in an interventionist way. They decided who could use spectrum, the services they could provide and the technologies they could use. We rejected this approach in the SFR, instead favouring

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[22] www.ofcom.org.uk/consult/condocs/psb3/psb3.pdf.
[23] www.ofcom.org.uk/tv/psb_review/childprog/.
[24] www.ofcom.org.uk/research/tv/reports/newnews/newnews.pdf.
[25] www.ofcom.org.uk/tv/psb_review/c4review/c4review/statement.pdf.
[26] www.ofcom.org.uk/tv/psb_review/psb_2review/psbreview2.pdf.
[27] www.ofcom.org.uk/research/cm/broadband_rpt/broadband_rpt.pdf.

market mechanisms to allow users more flexibility in determining spectrum use and to accommodate the increasing demand for spectrum. A market led approach entails:

- allowing spectrum to be traded between users;
- liberalising spectrum by imposing as few constraints as possible on its use and removing existing restrictions limiting use to certain services or technologies; and
- awarding spectrum through service and technology neutral auctions or, where spectrum is already licensed, introducing AIP to ensure that licence fees provide incentives to use spectrum efficiently by reflecting its value.

4.15 We believe that this approach will:

- promote efficient spectrum use by allowing it to be transferred to, and used by, those who value it most highly;
- promote competition by increasing the availability of spectrum for use in the most valuable services; and
- facilitate innovation as new providers enter the market to offer new services.

4.16 These characteristics of a market led approach all tend to bring positive benefits to citizens and consumers and are therefore consistent with our duties. They are also directly relevant to our objective for the DDR.

Objective for the DDR

4.17 Taking account of our duties and our spectrum management strategy, and as set out in the DDR consultation document, our objective for the DDR is to maximise the total value to society that using the digital dividend is likely to generate over time. It is emphatically not our objective to award the digital dividend to maximise revenue for the Exchequer. Given our duties, this is not a consideration we take into account.

The total value framework

4.18 The DDR consultation document summarised the key elements of total value that are relevant to consumers and citizens. These are respectively:

- consumer value. This includes the value we derive as consumers when we engage in markets by using goods or services. This is derived from serving consumer interests in relation to both access to and participation in markets; and
- broader social value. This includes the value we derive as citizens from goods or services. This is derived from the provision of and access to goods or services that meet social goals.

4.19 Access to and use of services can therefore generate both consumer value and broader social value.

Consumer value

4.20 There are well established techniques for assessing consumer value. These involve assessing the benefits consumers gain from consuming goods and services over and above what they have to pay for them (commonly referred to as consumer surplus).

Broader social value

4.21 Broader social value can be thought of as a form of externality (i.e. spillover effect) that affects us as citizens. When services that meet broader social goals (e.g. universal access to telecommunications or PSB) are provided and consumed, this generates broader social value.

4.22 To understand better how the different uses of the digital dividend might generate broader social value, we have identified the following elements:

- access and inclusion (e.g. value derived from universal access and facilitating access to public services);
- quality of life (e.g. value derived from providing access to services that improve quality of life by promoting work/life balance or family life);
- belonging to a community (e.g. value derived from allowing people with similar interests to communicate and/or participate in the local community);
- educated citizens (e.g. value derived from services with educational content or child oriented services);
- cultural understanding (e.g. value derived from services that reflect and strengthen cultural identities or promote diversity and understanding of other cultures);
- informed democracy (e.g. value derived from services that provide information facilitating democratic debate); and
- social bads, including negative value derived under any of the elements above.

4.23 The DDR consultation document set out a number of ways in which broader social value generated by particular uses of the digital dividend might be assessed. It noted that we would use the following three methods:

- quantitative market research that assessed the value citizens and consumers attached to these uses, including trade-offs based on their importance to society;
- deliberative market research to assess citizens' preferences for different possible uses of the spectrum; and
- an assessment by an academic in this field, Dr Damian Tambini.

4.24 A more detailed discussion of broader social value and its measurement can be found in annex 2 to the DDR consultation document.[28]

Assessing total value to society

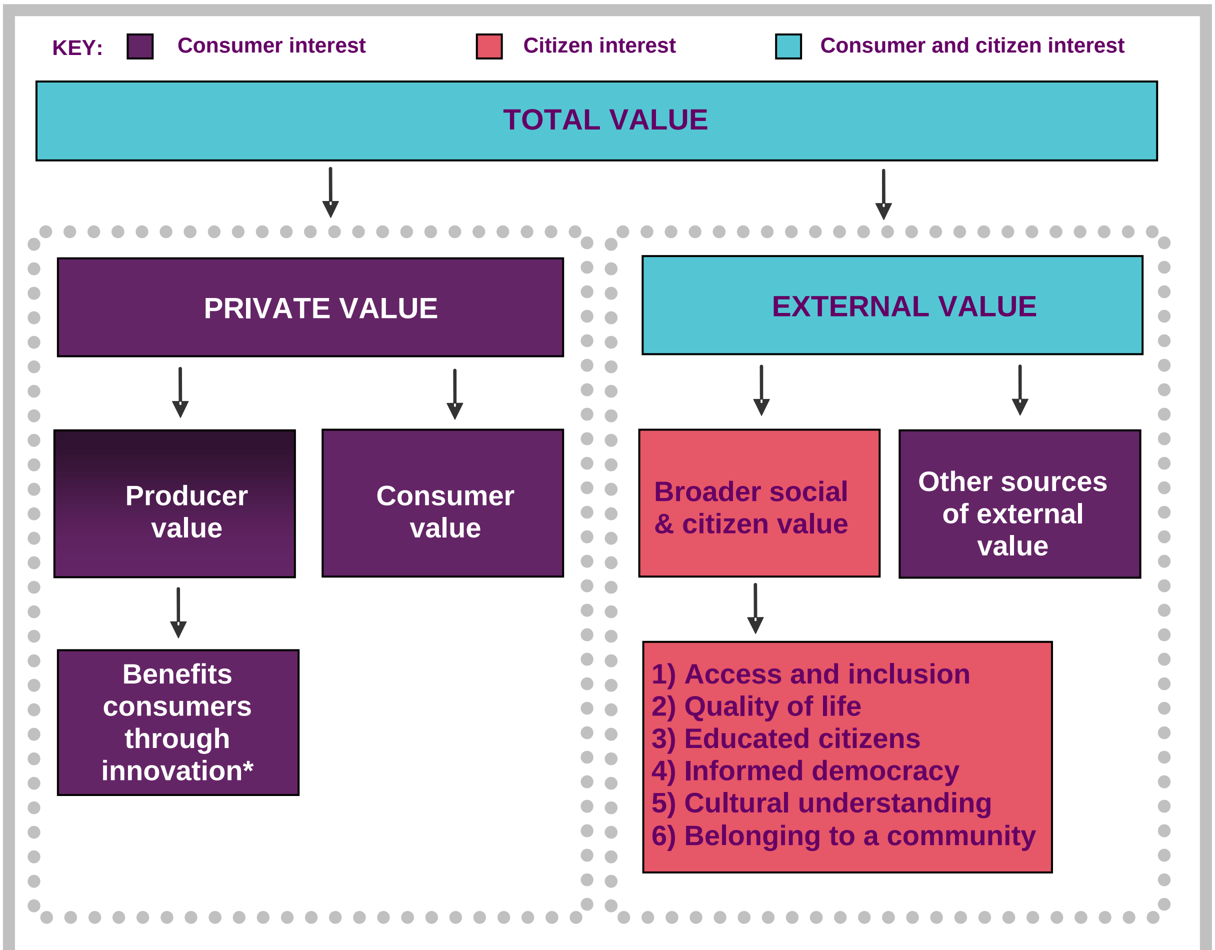
4.25 Combining consumer value and broader social value with two other sources of value, producer value and other externalities, gives the total value of producing and consuming a particular good or service. Figure 4 illustrates this. In deciding how to award the digital dividend, we must consider the potential value to society of different uses of the spectrum. We use this total value framework to do so. We are particularly

[28] www.ofcom.org.uk/consult/condocs/ddr/ddr_annexed.pdf.

concerned with assessing broader social value and the extent to which it differs across uses or is unrelated to the private value generated by a use. When this happens, there is a risk that a market led award could result in a socially suboptimal outcome (i.e. one in which total value is not maximised due to market failure).

4.26 It is important to stress that, in applying this framework throughout the DDR, we have sought to ensure that we assess the incremental effect on total value of using the digital dividend . This means looking at effects over and above those of other services already available and other options for delivery.

Figure 4. The total value framework



* Producer value should be taken into account owing to the knock-on effect of innovation on consumer (and, in some cases, citizen) value. However, consideration might need to be given to the weight given to producer value relative to consumer and citizen value.

Conclusion

4.27 This section has considered:

- how we have interpreted our relevant duties in formulating our spectrum management strategy in general and our objective for the DDR in particular; and
- the total value framework that we have used to help us evaluate whether different approaches to awarding the digital dividend would be likely to meet that objective.

Section 5

How to identify if a market led approach is right for the DDR

Introduction and summary

5.1 This section considers how we should go about answering the strategic question of whether following a market led approach will meet our objective for the DDR or whether we should depart from this by intervening to determine how the spectrum is used (i.e. an interventionist approach).

5.2 We have answered this question by starting with a market led approach and considering whether there are reasons why this might fail to maximise total value. Where we find the potential for market failure, we consider the range of options we have for remedying this. These include options consistent with a market led approach (i.e. which help the market to work) and options that involve moving to an interventionist approach. Our approach weighs up the costs and benefits of not intervening against the costs and benefits of intervening (taking into account the opportunity cost of the intervention and the potential for regulatory failure to increase this). This trade-off allows us to identify whether the total value generated by using the digital dividend is likely to be greater if we intervene and hence depart from our market led approach.

5.3 We also explain how our total value framework applies to decisions about licence exempting the digital dividend.

5.4 This section focuses on the factors we take into account when conducting our assessment. Sections 6 and 7 apply this approach to decide:

- whether we should set aside spectrum for licence exempt use; and
- whether we should adopt a market led approach for potential licensed uses of the digital dividend.

5.5 Our approach to answering this strategic question was first set out in the DDR consultation document. This section addresses responses on its suitability.

5.6 This section therefore considers the following issues:

- how our approach to answering the strategic question involves trading off the costs and benefits of a market led approach and an interventionist approach;
- how markets can deliver total value;
- how markets can fail and our approach to assessing the importance of this issue; and
- what options are available to remedy market failure and how the likelihood of regulatory failure can be reduced.

Consultation responses

5.7 The DDR consultation document sought comments on our analysis of the choice between a market led approach and an interventionist approach to awarding the digital dividend. We received 260 responses (167 from individuals) on the desirability of a market let approach and 138 (77 from individuals) on the risk of market failure. Views were deeply polarised. Annex 4 sets out responses in detail.

5.8 A number of respondents, from all sectors, did not regard the choice as starkly between one approach or the other. Some noted licence exemption as a third approach. Some recognised the Government's role in funding public services that require spectrum, albeit with varying degrees of confidence that this would happen. Others supported our proposals for a market led approach and recognised a need to intervene in the event of market failure but noted that intervening might have unpredictable effects.

5.9 In general, telecommunications and ICT organisations, along with some public bodies, supported a market led approach. Mobile network operators (MNOs) and mobile equipment manufacturers restated the benefits of taking a common approach across Europe and noted that EU harmonisation measures could affect use of the digital dividend. The Ofcom Spectrum Advisory Board (OSAB) echoed both views.

5.10 Our Advisory Committee for Northern Ireland (ACNI) generally supported the market led approach. So did the Ofcom Consumer Panel (OCP), while looking to us to set out clearly how we would rectify the possible outcome that the broader social value of a service was not being maximised in the marketplace. Our Advisory Committee for Scotland (ACS) and our Advisory Committee for Wales (ACW) had more concerns about an exclusively market led approach, whereas our Advisory Committee for Older and Disabled People (ACOD) saw a need to promote access for non-commercial service providers.

5.11 PSBs, certain manufacturers, some other organisations and a large number of private individuals argued for spectrum to be reserved for specific uses such as DTT services in HD. Generally, these respondents did not consider a market led approach to be appropriate, for a wide range of reasons including:

- the unsuitability of auctions for realising broader social value. Some respondents proposed reserving spectrum for social use, others imposing obligations on auction winners to set aside capacity for such use, yet others providing bidder credits for those generating broader social value;
- the need to allocate spectrum to particular services (e.g. those generating broader social value) even if specific assignments were subsequently auctioned; and
- an inability to take part in an auction, notably on the part of PMSE users, who considered themselves typically to be small and under-resourced.

5.12 Other respondents raised a wide range of market failure issues which they thought we needed to consider. Annex 4 sets these all out.

Our response

5.13 We agree that the potential for market failure requires very careful consideration. The analytical approach we set out in this section is the way in which we do this. We think this approach is sufficiently broad to capture all important sources of market failure and allow us to reach a reasoned judgment on the need to intervene.

5.14 Many responses about our approach to assessing whether to intervene fit into one of the following common themes:

- questions about whether a market led approach can really be used to deliver value to society. These comments raised concerns about the suitability of public funding for delivering broader social value and suggested alternative approaches (e.g. reserving spectrum), which respondents considered preferable;

- comments about the range of market failure issues we should consider and questions about whether our approach captured all these; and

- recognising the need to be careful when intervening as this can have unexpected effects.

5.15 We have taken the consultation responses into account in assessing whether we should adopt a market led approach or an interventionist approach. We explain below our approach to this assessment and why we think it is the right one. Our response to the three themes above can be found as follows:

- we address questions about whether a market led approach can work and the suitability of alternative approaches to delivering broader social value first in discussing how markets can deliver total value (paragraphs 5.31-5.38) and second in assessing the different intervention options available for resolving market failures (paragraphs 5.59-5.70);

- when setting out the framework we use to identify market failures (paragraphs 5.39-5.47), we explain why we think this is broad enough to capture all important market failure risks; and

- in considering what to do when markets fail (paragraphs 5.48-5.58), we show how our approach takes account of the potential for intervening to have undesirable effects.

5.16 We have noted the comments that we should not characterise licence exemption as a form of intervention. We agree that there are approaches to licence exemption that allow markets to play a role (e.g. using general licence exempt allocations rather than application specific allocations so the market can determine which licence exempt applications should make use of the available spectrum). However, in deciding whether to licence exempt the digital dividend, we believe that our total value framework is still appropriate:

- licence exemption decisions are required because of market failures—namely transaction costs—that prevent a large number of individual users of low power applications from aggregating their demand effectively;

- these uses are also often characterised by incentives to free-ride. Individual users typically do not reduce the usability of the available spectrum for other users (i.e. they do not create harmful interference for other licence exempt users and in some cases can share spectrum with licensed uses without causing interference), and each individual user represents only a small amount of the overall demand for this use. These two factors, when combined with the practical difficulties involved in excluding users able to purchase consumer equipment, can provide strong incentives for free-riding if this use were to bid for spectrum;

- in these situations, our total value framework is a useful way to implement our economic value test from the SFR, which we consider to be the appropriate approach to these decisions. Additionally, this approach helps us to recognise the importance of considering regulatory failures when making licence exemption decisions, as with other forms of regulatory decision; and

- this approach is consistent with our duties under EU and UK law in relation to licence exemption. When uses do not create harmful interference, they will be subject to the market failure risks identified above. Additionally, when this situation is present, the most appropriate regulatory response is clearly to exempt the use from licensing but in the most flexible manner possible (i.e. using general rather than application specific allocations).

5.17 We also acknowledge the concerns raised by some respondents about the need to promote harmonisation. Section 3 explained how our approach to awarding the digital dividend is consistent with market led harmonisation of spectrum use across the EU and elsewhere in the world.

Trading off a market led approach and an interventionist approach

5.18 Our approach to the strategic question facing the DDR is to trade off the costs and benefits of a market led approach and an interventionist approach as both have advantages and disadvantages. At the heart of this assessment is a consideration of potential market and regulatory failures. Before considering the merits of the two different approaches, we first define market and regulatory failures.

5.19 In the context of the DDR, we would consider a market to have failed if:

> a well designed auction of rights to spectrum that is subject to only the minimum constraints on use would not achieve an efficient outcome—that is to say, the holding and exploitation of spectrum by the users and for the uses that generate maximum value for society over time.

5.20 Regulatory failure can be thought of as the counterpart of market failure. A regulatory decision would have failed if:

> a well designed regulatory intervention fails to achieve the benefits expected or causes unintended additional costs, which result in the decision failing to generate maximum value for society over time.

5.21 At a high level, the benefits of a market led approach are that it reduces the risk of regulatory failure, while the costs are that it may be subject to market failure. The merits of an interventionist approach are the reverse: if it works, it could remove any market failure, but this comes at the price of the risk of regulatory failure.

5.22 To understand the trade-off between these two approaches, it is important to consider the likelihood and significance of both market and regulatory failures in awarding the digital dividend.

5.23 Our work before publishing the DDR consultation document identified that there were two market failure issues particularly relevant to awarding the digital dividend. These are:

- transaction costs, driven by the need for some uses to coordinate in order to bid for spectrum. Where a large number of users need to aggregate their demand in order to bid for spectrum, this can result in transaction costs that artificially depress the amount they are willing to bid. Transaction costs may be a problem if spectrum is auctioned in packages significantly larger than the amount demanded by some of the individual users; and

- the presence of externalities, which are driven by the presence of broader social value generated by the potential uses of the digital dividend. Our work identified that many such uses generate value over and above their value to consumers and producers. This extra value accrues to us as citizens and is referred to in our total value framework as broader social value. It is therefore of great importance that our assessment of market failure takes a sufficiently broad view of value to society, including the benefits we all enjoy as citizens as well as consumers.

5.24 We also conducted detailed work to assess how significant regulatory failures might be. This suggested that regulatory decisions to reserve the digital dividend for potential uses would be particularly prone to regulatory failure. This is because of the uncertainty over the best use of this spectrum both now and in the future, the lack of information available to us and the potential for regulatory decisions about use to have undesirable effects on the incentives for spectrum efficiency. These issues are resolved by a market led approach because:

- where there is considerable uncertainty over which uses are likely to generate the highest value, market mechanisms can help to ensure that the spectrum is used by those who value it the most. This is because markets can act as an information discovery mechanism. Markets allow the superior information held by participants to be revealed and combined in order to identify those who have the highest value;

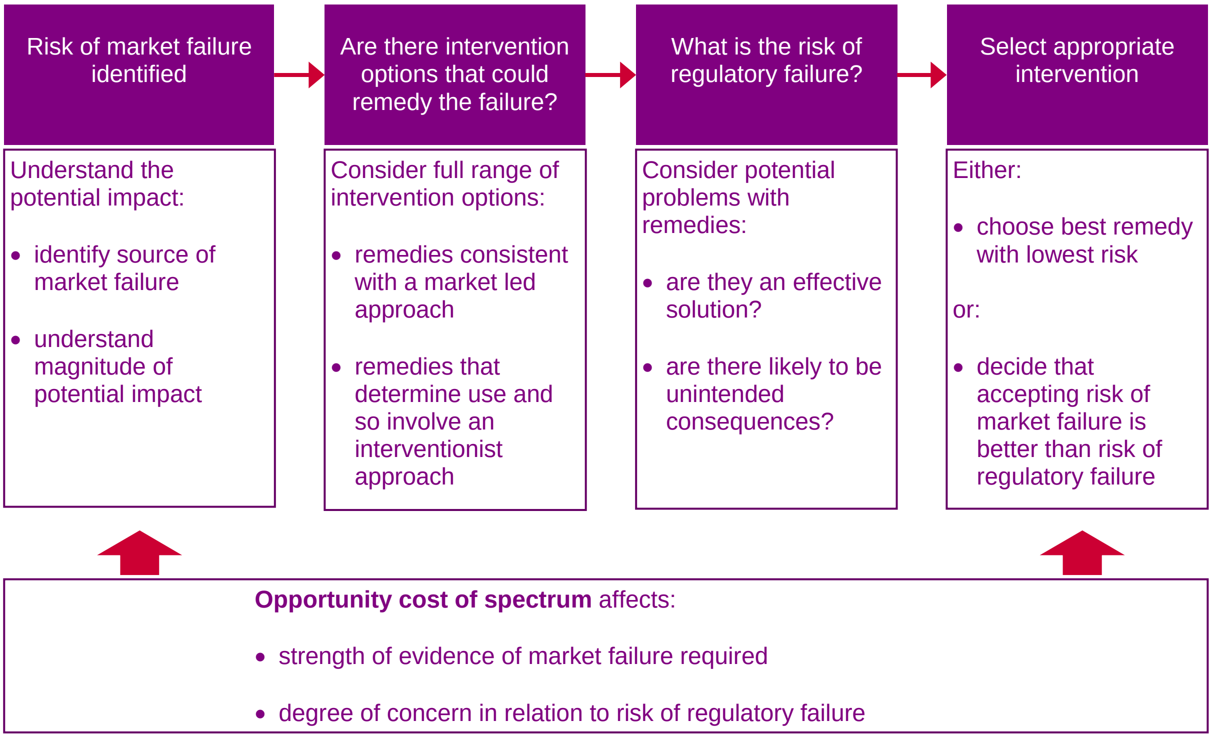
- market mechanisms also help to resolve uncertainty. This is because they reveal information by showing participants how much a resource is worth to others. This can help to resolve uncertainty. For example, if market mechanisms show that all my competitors are willing to pay more for the resource than I am, unless I understand the reasons for this, it might suggest that my valuation of the resource is too low; and

- information about value and flexibility of use give users strong incentives to get the most out of the spectrum they own and hence to ensure efficient use in the longer term and promote innovation. This may include, for example, changing the use to which spectrum is put and/or trading spectrum with other potential users. The ability to make these changes and to be flexible in responding to unforeseen changes quickly is particularly important for promoting efficient spectrum use in the longer term.

5.25 In considering how best to trade off the risks of market and regulatory failure, we have carefully considered the range of regulatory remedies available to resolve market failures. The reason for this is that, in some situations, remedies can resolve market failures without completely departing from a market led approach. This type of remedy is hence less prone to regulatory failures. Our work on the range of regulatory remedies is set out later in this section and in annex 2, but for now we point out that this work identified some remedies consistent with a market led approach. Hence, when trading off the costs and benefits of a market led approach and an interventionist approach, we take into account whether there are regulatory remedies that could be used under a market led approach and might therefore result in a better overall outcome when market failure is present than taking an interventionist approach.

5.26 Figure 5 sets out the approach we have taken to pulling these different considerations together.

Figure 5. Approach to trading off market led and interventionist approaches



5.27 The use of trade-offs in assessing whether to intervene needs to be kept in mind when interpreting our decisions. For example, when we reach a conclusion that intervening is not justified in relation to the presence of broader social value, this does not mean that the presence of broader social value is unimportant. To illustrate this, consider that our work has identified that many (if not all) potential uses of the digital dividend generate broader social value as well as high levels of private value. If we are to intervene to set aside spectrum, the types of question we might need to ask ourselves are:

- should we pick universal access to more DTT services in HD when this might mean we lose the opportunity of universal access to mobile broadband? or
- should we reserve interleaved spectrum for local television when this might mean that we lose the opportunity of a multiplex that could offer capacity to other socially valuable content?

5.28 Therefore, when deciding to intervene, we are not deciding between some broader social value or none. We are deciding whether we are likely to get even more value by intervening than we would without.

5.29 The remainder of this section provides further information on:

- how we identify and assess market failures; and

- how we identify intervention options that can resolve market failures and assess the risk of regulatory failure with these options.

5.30 But first, the presence of broader social value generated by some potential uses of the digital dividend was raised by some respondents to the DDR consultation as a reason why a market led approach should not be adopted at all. In response to these concerns, we explain how, in principle, markets can deliver many different sources of value.

How markets can deliver total value

5.31 To understand when markets might fail and how this problem can be resolved, it is important to understand the role markets can play in delivering total value.

5.32 Markets can be thought of as a mechanism for assisting decision making. They reveal information, more accurately and quickly than a regulator could. For parties to make efficient choices in a market, they need to have all the relevant information. When this is combined with other factors which are important for well functioning markets, such as defined rights of ownership[29], decision makers will have strong incentives to use the information provided by the market to trade off the costs and benefits of the decisions they are making efficiently.

5.33 Making these choices efficiently can deliver both high consumer value and value for citizens. This will be the case when services important to us as consumers are also highly valued by us as citizens. There is often a strong correlation between consumer and citizen value. For example, mobile services are highly valued by consumers and, as our market research indicates, by citizens, too. This is why, in assessing market failures, we are interested in different relative levels of broader social value. Where all services generate broader social value and this is similar in proportion to the private value they generate, we would expect a market to result in a good outcome for citizens as well as consumers.

5.34 In some cases, there may not be a strong correlation between citizen and consumer value. This does not mean that markets cannot work. Citizen value can be thought of as a form of externality. If this effect is captured in decision making, a market can still arrive at efficient decisions. The existence of broader social value in some activities is a fundamental reason for the existence of government and its power to fund those activities through taxation. So the presence of externalities is not specific to the digital dividend or spectrum management but is, rather, a much wider issue at the heart of public policy.

5.35 If the provision of funding is tied to an obligation to deliver a socially desirable outcome, the body in receipt of this funding can engage in a market to acquire resources with all the information and incentives it needs to make efficient choices.

5.36 There are many examples of public services (e.g. the NHS and state education) whose existence is a response to the existence of broader social value. As a general rule, these services are expected to acquire the inputs they need at market prices. The regime for funding these services recognises this: it is generally on a transparent

[29] There are a variety of factors which are generally required for a well functioning market, in addition to those mentioned in this discussion, other factors which are relevant include effective competition, and institutional arrangements which promote trust between transacting parties. Further discussion of the factors required for well functioning markets can be found in “Reinventing the Bazaar: The Natural History of Markets” by John McMillan, published in June 2002 by W. W. Norton & Company.

and explicit basis, through transfers of money rather than resources in kind like land, labour or equipment.

5.37 The alternative to allocating resources in a market is for decisions to be made centrally (e.g. by the government). This is what happens in a command economy in respect of the economy's resources as a whole. It is widely accepted that command economies face significant difficulties in making efficient choices precisely because they lack the information and incentives that market forces can bring.

5.38 Overall, we believe that using market mechanisms to make decisions about using the digital dividend is likely to bring benefits and will deliver total value as long as any external effects, such as the presence of broader social value, are either of a similar scale across different potential uses or reflected in the decisions made by those bidding for spectrum.

When markets might fail

5.39 As mentioned earlier, we define a market failure in the context of the DDR to be a situation in which a well designed auction of the spectrum does not result in those acquiring it generating the highest total value from its use.

5.40 Given this, we believe that our approach is sufficiently broad to capture all important risks of market failure. For example, we believe that all of the market failure risks that respondents identified as relevant considerations for the award of the digital dividend would result in one (or more) elements of total value not being maximised.

5.41 The outcome of this assessment was the identification of two types of market failure likely to be particularly relevant to that award. These were transaction costs and externalities. We set out below the considerations we take into account when identifying these market failures and assessing how significant they might be.

Transaction costs

5.42 If participating in a market led approach to awarding the digital dividend (i.e. transaction costs) is too costly or complex, some types of user may not take part. For example, some types of use involve a large number of individual users, each using a small amount of spectrum independently of others. If these users took part in a market led award, either they would need to coordinate their demand or someone would need to do it for them. This could be very costly, making it uneconomic for them to participate.

5.43 Transaction costs are relevant to low power uses that could access spectrum on a licence exempt basis. These uses will face further difficulties in accessing spectrum through a market because of incentives to free-ride. This is because their use of spectrum is in some respects non-rivalrous (i.e. it might not prevent others from using the spectrum) and may also in practice be difficult to prevent (e.g. if equipment is widely available). These are characteristics of uses that are suitable for licence exemption as they do not interfere with each other. When this is the case, each user would face an incentive not to contribute to an aggregate bid for spectrum. This is because they would be able to use the spectrum even if they did not bid, and they will not expect their own decision to have any significant impact on the aggregate bid. Because all users are incentivised to act in this way, the result is that the aggregate bid will be significantly lower and hence will fail to reflect the value of this use.

5.44 To understand how significant this type of problem might be, we have identified the types of use that would in principle be exposed to this type of market failure. These are low power uses, local television, PMSE and DTT. To assess the severity of the problem, we considered the nature of the coordination task involved and whether there is any evidence of prior coordination between relevant bodies. For example, demand for multiplex capacity on the DTT platform is already aggregated by multiplex operators. This would tend to suggest that coordination between broadcasters and multiplex owners to express demand for spectrum for additional DTT capacity should be feasible. The DDR consultation document identified that transaction costs, particularly coordination failures, are relevant to two potential uses of the digital dividend: PMSE and local television. Section 7 discusses coordination failures in relation to these two services in detail. Section 6 discusses the potential for low power uses to access the digital dividend.

Externalities: broader social value

5.45 Where spectrum is awarded under a market led approach (e.g. by auction), bids represent prospective users' valuations of it. Users with the highest valuation will acquire the spectrum as they will be willing to pay the most. As mentioned above, even when broader social value is present, this will result in an efficient outcome if spectrum users' willingness to pay is correlated with total value. In order words, this will be the case when the ranking of different users' bids is the same as the ranking of total value (i.e. the highest bid is from the use that yields the highest value for society).

5.46 This relationship is likely to hold when services highly valued by consumers are also highly valued by citizens. When this is not the case or some services generate disproportionately higher levels of broader social value than others, a market would not be expected to result in an efficient outcome.

5.47 We must therefore consider where market failure might arise because of the presence of broader social value. To understand the significance of this issue, the only credible options for us to take is to assess whether there is evidence that some uses generate differing levels of broader social value. Where this is the case, we then need to consider whether this is likely to result in differences in the ranking of willingness to pay for spectrum relative to total value across the potential uses of the digital dividend. Annex 2 discusses this issue and our approach to assessing whether this relationship holds across the likely uses of the digital dividend.

Identifying what to do when markets fail

Identifying options for intervention

5.48 To identify whether intervening is appropriate, we start by identifying the range of options likely to be effective in resolving the particular market failure at issue. This is because there is no one intervention option that can resolve all forms of market failure. We go on to consider which, if any, of these interventions might be justified given the magnitude of the market failure. This involves assessing the opportunity cost of the intervention and the risk of regulatory failure. Only when the benefits of resolving the market failure are greater than these costs might intervention be justified.

5.49 We have considered a wide range of options for resolving market failures. Annex 2 explains these, provides indicative examples of how the interventions might work and discusses their merits. Some of these interventions are consistent with a market led approach, while others involve increasingly significant departure from it and hence are interventionist approaches to resolving market failures.

Opportunity cost

5.50 If spectrum is used for one service, it is generally not available for others. One potential exception to this rule may be technologies that avoid interference (e.g. cognitive technologies, discussed in section 6). This lost opportunity is a real cost that we need to take into account. The opportunity cost is the value of the opportunity being denied to other uses or users.

5.51 For intervention to be justified, the opportunity cost of intervening must be less than the cost of the market failure without intervening. As the benefit of resolving a market failure is often difficult to establish with any degree of accuracy, the assessment of opportunity cost (which is in many cases easier to establish) provides a very important benchmark for assessing market failure. This is because it allows an assessment of whether the uncertain benefits could plausibly exceed the possible opportunity cost.

5.52 The assessment of opportunity cost is also a valuable indicator for the assessment of regulatory failures. If the opportunity cost of intervening is relatively low, the impact of regulatory failure is likely to be low. Conversely, when the opportunity cost is particularly high, a thorough consideration of regulatory failure is needed as the impact of getting the intervention wrong is likely to be high.

Regulatory failure

5.53 Regulatory failure will arise if we intervene in a manner that prevents maximum value to society being generated by using the digital dividend. Any intervention will have costs and risks of its own. These need to be considered alongside the potential benefits of intervening. Intervening may fail to achieve the benefits expected or have unintended consequences.

5.54 These costs can affect the welfare of society in far reaching ways. Interventions that restrict the use of the digital dividend as a way of addressing the risk of market failure would seriously distort choices made by users by reducing their incentive to use the spectrum efficiently. It is important to give users incentives to use spectrum in the most efficient way. Where users do not have such incentives, they are more likely to use too much spectrum relative both to other inputs and to other potential users.

5.55 Incentive effects are one example of the ways in which intervention can have a profound impact that is not fully predictable. These can be thought of as a dynamic cost to society. Other examples of dynamic cost include:

- loss of flexibility in spectrum use. Conditions that restrict spectrum use create a barrier to change if circumstances change. Relaxing or removing conditions may require further regulatory decisions, which in themselves can entail a slow and uncertain process, involving vested interests;

- adverse effects on competition. Setting aside spectrum for a particular use or user can make competition less effective at a variety of different levels. Competition between different platforms may be affected if one operator gains access to spectrum that confers cost advantages or benefits in quality of service not easily replicated by its competitors; and

- adverse effects on innovation. Innovation is an unpredictable process and benefits from innovators experimenting at low cost. By restricting spectrum to a particular use, the opportunity for experimenting at low cost and learning by trial and error could be lost.

5.56 A major problem that we face is the difficulty of assessing the effects of intervention. The more difficult this is and the more uncertainty there is, the more likely it is that the intervention will prove mistaken and the greater the risk of undesirable, unintended consequences.

5.57 We believe that there is a high degree of uncertainty over the future use of the digital dividend. This stems from:

- the wide range of potential uses and users of the spectrum that can be identified;
- the fact that many of these potential uses would be new to citizens and consumers;
- the existence of alternatives to the products and services that could be supplied using the digital dividend;
- the use of different spectrum for particular services;
- the development of alternative platforms for delivering particular services, which may use other spectrum or not use spectrum at all;
- consumer preferences in relation to media consumption; and
- the high likelihood of further innovation that could affect the possible uses of the digital dividend.

5.58 This uncertainty points to caution about intervening in a market led approach to awarding the digital dividend.

Identifying the best option for resolving each type of market failure

5.59 As mentioned above, different forms of intervention are best suited to addressing different sources of market failure. If we are to intervene in a market led approach to awarding the digital dividend for reasons of market failure, it is important that we do so appropriately. We now therefore consider the best forms of intervention to resolve the two key market failure risks in the DDR: coordination failures (transaction costs) and the presence of broader social value.

Transaction costs

5.60 Three forms of intervention might be effective for transaction costs. These are:

- resolving the failure through auction design and packaging;
- allowing spectrum use on a licence exempt basis; and
- reserving spectrum for a particular licensed use.

5.61 Appropriate auction design and packaging allow the market failure to be resolved without departing from a market led approach. This option generally works by changing the characteristics of what is auctioned so that the need to coordinate is removed. As this option allows the market to decide the use to which the spectrum should be put, it is less prone to the regulatory failure risks set out above. This option also allows the market to trade off the benefits of the intervention with the opportunity cost as the use for which the coordination failure has been removed will only gain access to spectrum if the auction reveals that it is the highest value use.

5.62 Licence exemption and reserving spectrum for a particular licensed use are more interventionist options. They involve the regulator deciding how the spectrum should be used. However, in some situations, this may be required.

5.63 Licence exemption is the appropriate intervention option for resolving coordination problems when there are low power uses that do not cause harmful interference and hence are also likely to be subject to a risk of free-riding as well as facing transaction costs. As this involves the regulator deciding on the use of the spectrum, this type of decision could be subject to a high risk of regulatory failure. However, this can be mitigated. For example, if licence exemption is flexible (i.e. involves general rather than application specific allocations), this can at least allow the market to determine which applications should use the allocation, even though the decision between licence exempt and licensed use is made by the regulator.

5.64 Reserving spectrum may be required when the coordination difficulties faced by users requiring licensed spectrum access cannot adequately be removed through appropriate auction design and packaging. As with licence exemption, this type of intervention is likely to be prone to a high risk of regulatory failure. However, there are generally fewer options for mitigating the risk under this option.

Broader social value

5.65 The DDR consultation document noted that the best way to generate broader social value is generally for providers to be directly funded to deliver socially desirable outcomes. Intervening in spectrum management is generally not the answer, especially as alternative means of delivering services often exist.

5.66 We received many responses that questioned this position and argued that we should intervene by reserving spectrum for particular uses.

5.67 Reserved spectrum has, in the past, been used as a substitute for direct funding. However, there are a number of significant disadvantages to using spectrum as a form of funding:

- decisions in relation to funding from taxation rest properly with the Government and Parliament. Funding activities that generate broader social value is a fundamental reason for the existence of government and a function of many other public and private sector organisations;
- using subsidised inputs (e.g. spectrum) instead of funding can reduce incentives to use resources efficiently. Making one input artificially cheaper than others will generally result in that input being over-consumed; and
- for the many reasons set out earlier, reserving spectrum for a particular use can be very costly. Not only does it have a significant opportunity cost, but it can also be subject to regulatory failures through, for example, the negative effect it has on the ability to change the use and ownership of spectrum quickly in the future in response to new technological developments.

5.68 We continue to believe that direct funding remains the best way to address the risk of market failure caused by the existence of broader social value in awarding the digital dividend. It significantly reduces risks of regulatory failure (e.g. distorting the flexibility of future spectrum use and unintended consequences materialising as a result of intervening). In reaching this decision, we have carefully considered a wide range of other options, such as reserving spectrum and bidder credits. Our analysis of these options, set out in annex 2, has confirmed our original assessment that direct funding is the best option.

5.69 The Government has confirmed to us that it has not identified any reason to believe that current financial and institutional frameworks would, in principle, prevent public sector users or other providers of socially valuable services from bidding for access to spectrum at auction. Its view is that current frameworks already provide clear and established processes that allow the need for spectrum to be taken into account when reaching funding decisions, including where necessary through an increase in the funding of such providers of socially valuable applications. This position was set out in a letter dated 10 October 2007 from the Minister of State for Competitiveness to Ofcom's Chief Executive (see annex 10).

5.70 Some responses to the DDR consultation document questioned the feasibility of direct funding. Some suggested that institutional issues might impede either its provision or its use. We have given this some thought (our analysis is covered in annex 2), and we will give further consideration to how auction design can help bodies reliant on public funding to take part in an auction of the digital dividend.

Conclusion

5.71 This section has:

- set out our analytical approach to assessing whether we should take a market led approach to the award of the digital dividend;
- explained how our approach identifies market failures that may arise in the award and helps us to identify options for remedying problems that do arise;
- explained how decisions about licence exemption can be made using this approach;
- shown how our approach involves consideration of the cost of intervention (i.e. opportunity cost, regulatory failure and the associated cost of unintended consequences); and
- concluded that our analytical approach to assessing whether a market led approach to awarding the digital dividend is appropriate.

5.72 Section 6 applies this approach to the question of licence exempting the digital dividend. It also considers whether we should set aside spectrum as an innovation reserve. Section 7 goes on to apply the approach to the most likely licensed uses of the digital dividend to allow us to conclude whether or not a market led approach is justified given our objective of maximising the total value to society that using this spectrum generates over time.

Section 6

Licence exemption and an innovation reserve

Introduction and summary

6.1 This section considers the extent to which we should make the digital dividend available by licence exemption rather than by licensing specific rights of use. It also considers whether we should hold back some of the spectrum as an innovation reserve. The decisions we have reached are as follows.

6.2 We propose to allow cognitive equipment to use interleaved spectrum on a licence exempt basis provided it can operate without causing harmful interference to licensed uses.

6.3 We are not persuaded that licence exempt applications of a sufficiently high value to displace licensed use of the digital dividend will emerge in the foreseeable future. Therefore, we do not believe it appropriate to set aside cleared or interleaved spectrum for dedicated licence exempt use.

6.4 We do not believe that it is appropriate to hold back spectrum as an innovation reserve. This might reduce the total value generated by using the digital dividend because some users might be unable to acquire all the spectrum that they need to offer high value services. There is also unlikely to be a single “eureka” moment when a new use clearly becomes viable. Instead, there will be a series of steady, incremental changes. Finding a trigger point to release the reserve will be difficult, with the possibility that the spectrum might be held for a long time awaiting some better use that might always be imminent. In addition, there are other ways in which we can allow future uses of the digital dividend to provide services highly valued by citizens and consumers.

Licence exemption

6.5 The DDR consultation document sought views on whether there were likely low power uses for which we should make the digital dividend available on a licence exempt basis.

6.6 We also proposed licence exempting PMSE equipment to use some or all of channel 69. Section 7 considers this alongside the rest of our proposals for PMSE.

Consultation responses

6.7 We received 144 responses on licence exempt low power use. Respondents were generally not in favour of setting aside cleared spectrum for licence exempt low power use. These included network providers, broadcasters, manufacturers, MNOs, telecommunications operators, PMSE users and consumer bodies. They thought other uses were more valuable, particularly given that other spectrum is available for licence exempt use.

6.8 There was some support from our national advisory committees and some consumer and citizen groups on the grounds that this could foster innovation.

6.9 Low power users and community groups supported licence exemption in both cleared and interleaved spectrum due to the increasing number of low power uses, leading to crowding and interference in other bands. They noted that the characteristics of the digital dividend are much better than other available spectrum for these uses.

6.10 The 97 responses from individuals were mixed. Those not supporting licence exemption were concerned about interference, particularly to PMSE use of interleaved spectrum, and noted that other spectrum was available for licence exempt use. Those in favour raised the benefits (including broader social value) of potential uses and noted the advantages of future-proofing by setting aside spectrum for licence exempt equipment.

6.11 The DDR consultation document did not specifically ask whether we should allow access to interleaved spectrum for cognitive equipment. Nonetheless, certain respondents were strongly in favour of the idea. These included a major software developer, a consumer electronics firm and a network equipment manufacturer as well as open spectrum advocacy groups.

Our response

6.12 We have considered licence exempt use of both interleaved and cleared spectrum. We have considered reserving spectrum solely for licence exempt devices and allowing access on a cognitive basis. We have also considered the potential uses to which licence exempt devices may be put and thus the incremental benefit that might be conferred by access to the digital dividend.

6.13 These considerations allow us to apply our total value framework in order to assess whether we should set aside spectrum on a licence exempt basis as:

- identifying potential licence exempt uses and assessing their incremental benefit allows us to assess the likelihood and significance of market failure;
- considering both reserved and cognitive use allows us to assess whether there are interventions that could be effective solutions to this problem. We can then assess the opportunity cost and regulatory risk of these two options; and
- we can pull these two elements of the analysis together to assess whether setting aside spectrum for licence exempt use is likely to result in higher total value (i.e. whether the incremental benefit of licence exempt uses is likely to exceed the opportunity cost and whether the likelihood of regulatory failures affects this assessment).

Introduction to reserved spectrum and cognitive access

6.14 Spectrum can be reserved solely for use by licence exempt devices. With this approach, there is no licensed user. This has historically been the approach taken with most licence exemption. For example, DECT telephones, Wi-Fi and now citizen’s band radios all operate in spectrum that is reserved for licence exempt use.

6.15 There are also licence exempt devices permitted to operate in spectrum licensed to another use. Harmful interference between the licensed and licence exempt device can be avoided in two main ways:

- the licence exempt device can transmit at a low enough power level not to cause disruption to the licensed use. This is the method employed by UWB technology; and

- the licence exempt device can transmit only when the licensed user is not transmitting. Cognitive access is the ability to detect unused spectrum for this purpose.

6.16 Although cognitive access technologies are still in development, we believe that most licence exempt applications could make use of either reserved spectrum or cognitive access to the digital dividend.

Potential uses

6.17 As discussed in our Licence Exemption Framework Review (LEFR)[30], some 18 GHz of spectrum is currently allocated to licence exempt use in the UK. This supports a range of diverse applications, with telemetry services predominantly occupying bands below 1 GHz, broadband wireless communications between 2 and 6 GHz and short range radars and relays at 10 GHz and above. In both the LEFR and the SFR, we explain that our approach to identifying whether further spectrum should be made available for licence exempt use is based on responding to demand and, when so doing, by licence exempting spectrum only when the economic value generated by this use is expected to exceed that of likely licensed uses.

6.18 A number of potential uses of the digital dividend have been mooted for licence exempt applications. Some of those suggested by respondents and proponents of licence exempt use include:

- home networks, including automation and control;
- business networks;
- community and campus networks;
- municipal Wi-Fi;
- Internet connection sharing by multiple households;
- industrial monitoring and automation;
- agricultural monitoring and automation;
- rural broadband provision;
- ubiquitous wireless networks;
- sensor based networks;
- remote patient monitoring and healthcare; and
- an alternative nationwide broadband wireless network.

[30] www.ofcom.org.uk/consult/condocs/lefr/lefr_statement/lefr_statement.pdf.

6.19 Many of these applications would rely not on large scale national network providers but rather on small scale networks deployed in homes or by organisations such as businesses and public sector bodies. This raises the risk of coordination failure if they need to acquire licensed spectrum at auction. Furthermore, these uses may be largely geographically disparate and could be engineered so as not to compete in their demand for spectrum. For example, agricultural, industrial, campus and community networks would tend to operate in different areas and may not therefore be rivals for the same spectrum. When combined with difficulties in excluding users in practice (as many of these uses involve self-deployed networks enabled by consumer equipment), these factors suggest that licence exemption might be the best way to unlock the potential value of these applications. Equipment manufacturers showing interest to date have all indicated a preference for a licence exempt approach.

6.20 Most of the applications above could be rolled out using existing licence exempt allocations in the 2.4 GHz and 5 GHz bands, which we believe are not overcrowded. However, there would be a number of advantages to using the digital dividend. It would provide greater range and better propagation for the same power consumption than other spectrum. This would benefit some potential uses by requiring less network infrastructure (e.g. closed circuit television cameras for industrial monitoring). The digital dividend could also provide a similar range to other licence exempt bands with lower power consumption. This could be particularly beneficial in applications such as agricultural monitoring, where devices may have to be battery powered.

6.21 The key benefit for these applications of using the digital dividend is likely to be lower costs of deployment. Indicative modelling that we have conducted suggests that the economic value that might be generated by these applications with access to enough of the digital dividend might be in the region of £150-250m (NPV over 20 years)—see annex 8 for further detail. This is an illustrative figure. It only takes into account the uses listed above and assumes that they can all be rolled out using higher frequency spectrum. If these or new applications or services are only viable in the digital dividend, the value may be correspondingly higher. Conversely, if some of the proposed applications do not come into use, the value could be lower.

Use of interleaved spectrum

6.22 We consider next whether interleaved spectrum is usable for licence exempt devices, whether low power or cognitive. We consider whether the characteristics of this spectrum make it suitable for this type of use, and we examine the merits both of allowing cognitive access and of a dedicated licence exempt allocation.

6.23 Interleaved spectrum is a substantial resource. Analysis suggests that, at any one location, around 100 MHz on average is not being used by DTT and could, in principle, be used by licence exempt devices.[31] Such spectrum availability would be particularly beneficial for some of the high bandwidth services mentioned above,

[31] Figure derived through a radio planning model which measured the probable strength of incoming signals in the spectrum reserved for DTT. Where the signal strength was higher than a specific cut-off point, this channel was deemed to be unusable. There are two reasons why this may be a conservative measure. First, it measures outdoor field strengths. If a licence exempt device was being used indoors, a distant DTT signal on a particular channel would be correspondingly weaker. Second, this measure is conducted on a geographic average, so sparsely populated areas on the boundaries between DTT transmitters register as having fewer channels available. Work suggests that if the measure were weighted by population, the amount of available spectrum would be higher.

such as home and business networks, community and campus networks and municipal Wi-Fi.

6.24 We have already proposed that PMSE users continue to have access to interleaved spectrum through a band manager. There are other potential licensed uses, such as local television and more DTT. This will mean that some of the available interleaved spectrum is used by licensed services. However, there is still likely to be (potentially significant) capacity available, which could be used by licence exempt devices in many areas, at least for some of the time (e.g. when wireless microphones are not in use).

6.25 Given the nature of interleaved spectrum, we do not think that reserving any for licence exempt use would be appropriate. Licence exempt devices without cognitive abilities could not be safely used in the same channel of interleaved spectrum across the UK because DTT and other services would be using them in some locations. Reserving specific channels in interleaved spectrum in specific areas for licence exempt use would also reduce its flexibility and would be expected to result in a lower availability of spectrum for licence exempt devices as it would be difficult to set aside anywhere near as much as 100 MHz without unduly reducing the amount of spectrum available for licensed uses. Therefore, the incremental benefits of reserving spectrum for licence exempt use are likely to be low, and the costs of doing so could be high as this may preclude licensed uses and reduce the flexibility of use of interleaved spectrum.

6.26 In contrast, cognitive devices could make flexible use of interleaved spectrum without causing harmful interference to licensed users. This would allow many of the applications set out above to be delivered at a low opportunity cost, resulting in substantial benefits. Other applications and innovations might also be spurred by the availability of a large pool of interleaved spectrum for licence exempt use.

6.27 Cognitive use of interleaved spectrum would depend on the development of effective spectrum sensing technology that would avoid transmitting in channels used by licensed services. Devices are being developed by a number of manufacturers, including Microsoft, Motorola and Philips. These companies have each submitted devices to the FCC for testing in the US. These devices are primarily designed to detect DTT and wireless microphone signals and, as such, would be suited for use in interleaved spectrum in the UK.

6.28 We therefore propose to allow cognitive technologies to use interleaved spectrum on a licence exempt basis subject to establishing that the probability of harmful interference to licensed users will be low. It is likely that the total value generated would be greater than the opportunity cost of allowing licence exempt cognitive access. The total value would be composed of the private value of foreseen applications, which we estimate to be approximately £150-250m (NPV over 20 years), as well as benefits that would come from innovation and new services. There may also be broader social benefits. Because cognitive devices do not need to be exclusively assigned rights to spectrum and should automatically avoid interfering with licensed services, the opportunity cost should be low.

6.29 We would need to specify a number of parameters to which equipment would need to adhere. Early measurements made by the FCC suggest that such spectrum sensing is possible but careful certification might be needed. It may take some years to undertake the work necessary to gain appropriate international harmonisation.

6.30 We think that the risk of regulatory failure with this decision is relatively low as we are not preventing licensed uses, but we need to be mindful of the potential for cognitive access to have a negative impact on the future usability of interleaved spectrum when specifying the technical parameters for this use.

Use of cleared spectrum

6.31 Reserving cleared spectrum for licence exempt applications is an option. Indeed, this might be the only route to licence exempt use of cleared spectrum at the moment as cognitive use is likely to be complex and hence unachievable on a comparable timeframe, if at all, to the use of interleaved spectrum.

6.32 The current development of spectrum sensing technologies required for cognitive radio is primarily focused on detecting DTT and wireless microphone signals. As yet, it is unknown whether cognitive technologies would be able to detect and avoid other potential uses of cleared spectrum. This uncertainty cannot be resolved until it is known which licensed services will be using cleared spectrum.

6.33 It is also unlikely that cognitive use of cleared spectrum would yield a significant level of incremental access over and above what would be available under our proposals to allow cognitive use of interleaved spectrum. Dense services (e.g. 3G and successor two way services and mobile multimedia single frequency networks—SFNs) are unlikely to leave much unused cleared spectrum for these devices to exploit.

6.34 Therefore, we have focused our assessment on the potential benefits of setting aside cleared spectrum for dedicated licence exempt use. As licence exempt cognitive use of interleaved spectrum depends on testing, specification and possibly international harmonisation, some stakeholders have suggested that reserving cleared spectrum for licence exempt use might offer significant advantages:

- it might allow low power applications to be deployed more quickly. Based on our assessment that the value of licence exempt use of the digital dividend lies in the range £150-£250m, an incremental benefit of a few tens of millions of pounds might result from approximately two years' acceleration. However, this is crucially dependent on when working cognitive chipsets come to market. If this is before 2012, there might be no timing advantage to setting aside cleared spectrum;

- power consumption may be lower in devices that do not have to utilise spectrum sensing technologies. This would particularly benefit battery operated devices. However, the additional power drain associated with cognitive devices is as yet unknown. If the power required for spectrum sensing is low in comparison to overall power requirements, the magnitude of this benefit might be limited; and

- devices might be cheaper and create larger initial markets if they do not have to incorporate advanced cognitive technology.

6.35 However, there are significant disadvantages to setting aside cleared spectrum for dedicated licence exempt use. In particular:

- Microsoft and Philips suggested that three channels of cleared spectrum should be set aside. This is much less than is available through cognitive use of interleaved spectrum. It might not even be sufficient to accommodate certain high bandwidth multimedia applications. This indicates there may be small incremental value from licence exempt applications in cleared spectrum;

- our work suggests that setting aside three channels could have an opportunity cost of up to £1bn (NPV over 20 years). This is likely to be significantly greater than the incremental benefit that we believe would be generated by setting them aside for licence exempt applications;
- a decision to set aside spectrum for licence exempt use is likely to be prone to regulatory failure. This is because it is likely to reduce future flexibility of use of cleared spectrum as it can be difficult to switch spectrum quickly from licence exempt to licensed use if new higher value licensed uses emerge; and
- a degree of international harmonisation of cognitive equipment may be achievable in interleaved spectrum that is not possible to achieve in cleared spectrum. This is important in creating economies of scale and driving both new applications and potential innovation in licence exempt equipment. For example, the most defining factor in the continuing global success of Wi-Fi is the near global availability of the 2.4 GHz band. It is very unlikely that the same three channels of cleared spectrum could be harmonised for licence exempt use even in the EU due to competing demands and patterns of DTT use.

6.36 Overall, it seems very unlikely that the advantages of setting aside cleared spectrum for licence exempt applications exceed those of using it for licensed applications. We have therefore decided that cleared spectrum should not be set aside for licence exempt applications, as this would be unlikely to maximise the total value generated by the use of this spectrum.

6.37 Additionally at this time, we do not propose to allow cognitive use of cleared spectrum. The ability of cognitive devices to work in cleared spectrum is much more uncertain, and there may only be a small incremental benefit in allowing this over and above our proposal to allow cognitive use of interleaved spectrum. This leads us to believe that the associated costs to licensees of cleared spectrum might be too high given the size of the benefits. If, in the future, cognitive devices are developed that can be used in cleared spectrum, these could be used by licensees. Alternatively, as licences will be tradable, licensees could permit cognitive access to their spectrum.

Innovation reserve

6.38 The DDR consultation document invited views on the case for holding back a small amount of the digital dividend as an innovation reserve. This might benefit major technological developments, such as new low power uses, that could find it difficult to access the rest of the spectrum, even if it had been licensed on a flexible basis.

Consultation responses

6.39 We received 203 responses on this issue. Many were in favour of an innovation reserve as there was general concern that a market led approach to awarding the digital dividend could hamper or stifle innovation. However, very little evidence for this was provided.

6.40 Our advisory committees, consumer bodies, community/citizen groups and public bodies were supportive of an innovation reserve but noted that leftover auction lots might leave reserve capacity anyway. Respondents from the devolved administrations were also in favour.

6.41 Some broadcasters, manufacturers and local television operators were also broadly supportive but thought that account should only be given to known technologies to ensure the best use was made of the spectrum. Concerns were expressed about the length of time spectrum should be held in reserve and the practical difficulties involved in implementing the reserve.

6.42 Network and telecommunications providers were not persuaded of the need to hold spectrum back as they generally considered that secondary markets should be able to manage any new future use. They also considered that there would be a high opportunity cost and serious practical difficulties.

6.43 OCP proposed that, rather than holding spectrum back solely for innovation, we should consider putting some into a “spectrum bank” as a reserve for uses that have high broader social value but are not provided through the market.

Our response

6.44 Both benefits and costs could arise from the creation of an innovation reserve.

6.45 The primary benefit would be to provide spectrum if a high value application, unforeseen at the time of the award, were to emerge that could not find available spectrum to use. Such a new use could emerge, although our research indicates that no radically new uses are likely over the next 10 years.[32] We have also taken steps to minimise the likelihood that a sufficiently valuable new use would be unable to gain access to spectrum.

6.46 A new use with cognitive abilities would be able to take advantage of our proposal to allow licence exempt use of interleaved spectrum.

6.47 For a sufficiently valuable new use which required primary licensed access, two routes could allow its realisation through market mechanisms:

- we will release the digital dividend in as flexible a manner as possible. There will be strong incentives for new uses that deliver high value to citizens and consumers to be adopted by existing users; and
- because of the possibility of trading spectrum, there will be more opportunities to access the digital dividend to launch new services. If the new use is likely to generate more value then existing uses, it should be possible for potential acquirers to make attractive bids. If a socially valuable use requires access to spectrum in the secondary market, direct funding would be the best way to secure it.

6.48 The secondary market for spectrum is not yet well established. This is not surprising given that little spectrum is currently tradable. Far more will be tradable by the time the award of the digital dividend is completed thanks to the liberalisation of 2G mobile spectrum, implementation of the Cave Audit programme of reforms to public sector spectrum and the awards of spectrum at L-Band, 2.6 GHz and 10-40 GHz. We expect that this will result in a more active spectrum market that will more readily facilitate changes in ownership.

6.49 Concerns have been expressed about anticompetitive activity by licensees (e.g. hoarding) preventing new uses from gaining access to licensed spectrum. Section 10 explains our thinking on this issue.

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[32] www.ofcom.org.uk/research/technology/overview/techrandd0506/.

6.50 The measures set out above reduce the benefits of an innovation reserve. There are also significant drawbacks associated with this idea.

6.51 First, there is the problem of deciding when and for what use the innovation reserve should be released. There is unlikely to be a single “eureka” moment when a new use clearly becomes viable. Instead, there will be a series of steady, incremental changes. Finding a trigger point will be difficult, with the possibility that spectrum might be held in reserve for a considerable period because some better use is always imminent. Because the innovation reserve is held, by definition, for a future unforeseen application, even if such an application emerged, it would be impossible to demonstrate that another, even more valuable unforeseen application was not just around the corner. This could hamper innovation as it will result in considerable uncertainty about when the reserve would become available.

6.52 Second, the costs of holding spectrum in reserve are likely to be significant. As described above, setting aside three channels could have an opportunity cost of up to £1bn (NPV over 20 years).

6.53 Finally, the creation of an innovation reserve from cleared spectrum might distort an award process. With less spectrum available for award, certain kinds of bidder might be disadvantaged. This is more likely to affect new entrants and those wishing to offer high bandwidth services, both of whom might want larger amounts of spectrum than existing users who might only want to add incrementally to their holdings. Thus, creating an innovation reserve might actually have the unintended consequence of preventing new uses and users from gaining access to the digital dividend.

6.54 The same considerations would hold for a spectrum bank for socially valuable uses. Section 7 explains how these can acquire spectrum in a market led award. The same approach applies to acquiring spectrum through the secondary market if socially valuable uses emerge after the award. Therefore, we do not believe that setting aside spectrum in this way would be beneficial.

6.55 Separately, we are considering how our non-operational licensing regime can better enable services to move from testing and development to full commercial operation.

6.56 Although there could be some benefits to an innovation reserve, these appear small in magnitude, difficult to realise and already provided for by other measures that we are taking. Conversely, the associated costs appear high. Therefore, on balance, we have decided not to create an innovation reserve as we do not believe that this would be likely to generate higher total value from the use of the digital dividend either now or in the future.

Conclusion

6.57 This section has set out:

- our proposal to allow licence exempt cognitive use of interleaved spectrum, subject to verifying that this use will not cause harmful interference to other users;
- our decision not to set aside cleared spectrum for licence exempt use; and
- our decision not to hold back spectrum for an innovation reserve.

Section 7

Licensed use of the digital dividend

Introduction and summary

7.1 This section considers whether a market led approach to awarding the digital dividend is likely to lead to market failure for likely licensed uses. It explains our sources of evidence, including the results of our updated and expanded market research. It then considers the merits of intervention for each likely licensed use.

7.2 Evidence collected to date suggests some services are more likely to use the digital dividend than others. In addition to our market research, this comprises our own knowledge, consultation responses, technical research and economic modelling.

7.3 Given this evidence, we focus our analysis in this section on:

- PMSE;
- local television;
- DTT services in SD;
- DTT services in HD;
- mobile broadband; and
- mobile multimedia (mobile television).

7.4 After applying our analytical approach to each of these uses, we have decided that:

- PMSE users currently face a market failure risk due to transaction costs and coordination failures that is so severe that we need to adopt an interventionist approach to awarding spectrum suitable for their use. We expect them to be able to access spectrum through market mechanisms in the longer term. We think our approach to awarding spectrum will assist them during this transitional period;
- local television operators face a market failure risk due to coordination failures and timing issues, but this is best resolved by packaging under a market led approach;
- providers of DTT services in SD do not face a market failure risk that requires intervening in the award of the digital dividend. However, the provision of socially valuable content will be considered further in our second PSB Review;
- providers of DTT services in HD do not face a market failure risk that requires intervening in the award of the digital dividend. If there is a requirement for PSB content to be provided in HD in the future to secure broader social value, this can be achieved using the existing spectrum reserved for DTT;
- providers of mobile broadband do not face a market failure risk that requires intervening in the award of the digital dividend; and
- no identified market failure risks face providers of mobile television.

7.5 This section first analyses the evidence that we have gathered during the DDR and then, for each of the uses described above, sets out our assessment of market and regulatory failure. Annex 2 contains a more detailed explanation of our reasoning.

Evidence

7.6 The DDR consultation document set out and assembled a number of sources of evidence concerning, among other things, the elements of total value and the issues of market and regulatory failure. It contained first estimates from modelling work of producer, consumer and external values of a number of uses of the digital dividend. It was accompanied by a report summarising the findings of market research undertaken in 2006. We undertook and published initial analyses of external value and market and regulatory failures.[33/34] And we published technical analysis in the consultation document and separately,[35] considering among other things the potential set of uses of the spectrum.

7.7 We have continued to develop our thinking on the total value framework. Our principal sources of evidence are:

- new market research conducted in 2007;
- economic modelling;
- secondary research;
- technical analysis; and
- consultation responses.

7.8 New information from these sources has been used to update the analysis from the consultation document and inform our assessment of whether to adopt a market led approach as set out in this section. Each source of evidence is described below in terms of our work since the consultation and its role in informing the framework and assessing the elements of total value and the issues of market and regulatory failure.

Market research

7.9 The market research published with the DDR consultation document was undertaken to understand better citizen and consumer attitudes to a number of potential uses of spectrum in terms of value to society. These uses were DTT (SD, HD and local television), mobile television, mobile broadband, and wireless home networks.

7.10 The market research sought to:

- improve our understanding of the value to consumers and society of potential uses of the digital dividend, including using qualitative research techniques to explore in greater depth the value to society associated with new DTT, mobile television and mobile broadband services; and
- measure their relative importance and value to consumers and society.

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[33] www.ofcom.org.uk/consult/condocs/ddr/report_analysys/annexc.pdf.
[34] www.ofcom.org.uk/consult/condocs/ddr/report_analysys/annexe.pdf.
[35] www.ofcom.org.uk/consult/condocs/ddr/report_analysys/report_analysys.pdf.

7.11 A number of consultation respondents, mainly those arguing for spectrum to be set aside for DTT services in HD, criticised this market research on the grounds that:

- it was out of date, especially given how many HD ready television sets had been sold in the interim;
- it did not demonstrate technologies (especially HD television) to participants;
- the show cards used to describe uses of spectrum were not balanced; and
- other research undertaken for different bodies (e.g. the Freeview HD trial, Digital UK and the Digital Television Supply Chain Group) came to different, more positive conclusions about how much people wanted DTT services in HD.

7.12 We consider the market research undertaken in 2006 to be objective and robust. We do not accept the methodological criticisms made by some respondents. Our market research was notable in particular because it assessed citizen and consumer views of the trade-off between different potential uses, unlike most research undertaken by the proponents of a particular use such as DTT services in HD.

7.13 We did, however, seek to reflect respondents' concerns as far as we were able when conducting further market research in 2007. This was designed to supplement the research in 2006 by:

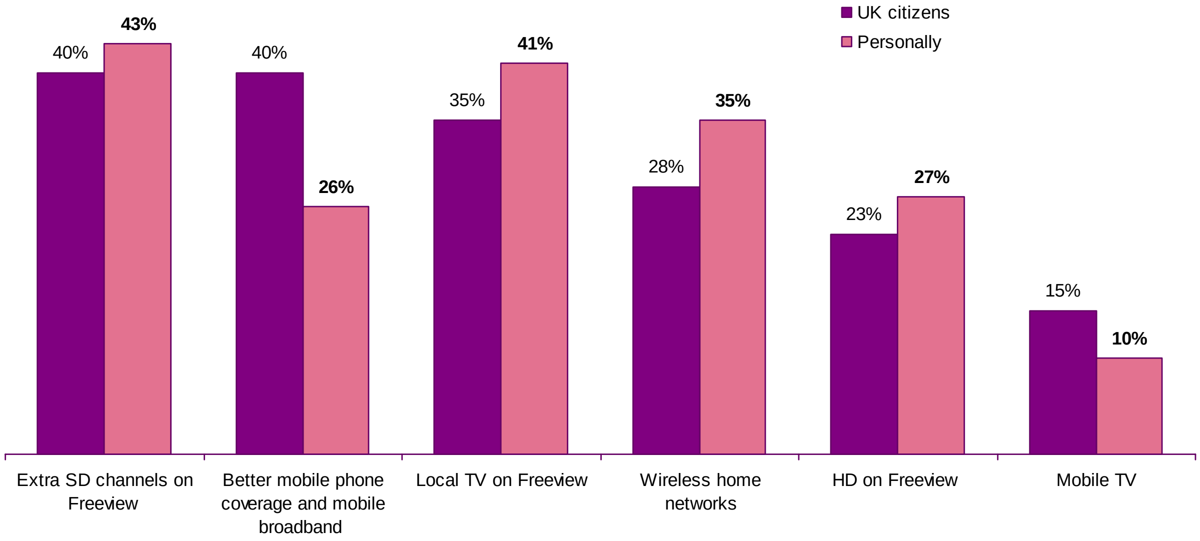
- reflecting changes in market conditions since the previous year;
- providing additional detail by assessing opinion among hard to reach subgroups;
- demonstrating the most likely potential uses in a fair and balanced way; and
- exploring a slightly different mix of potential uses of the digital dividend.

7.14 Further quantitative and qualitative research was undertaken during summer 2007. The quantitative research was carried out by Ipsos MORI, the qualitative by Opinion Leader Research. The qualitative research involved five deliberative workshops, each consisting of around 20 citizens representative of the UK population. Two workshops were held in London, two in Glasgow and one in Manchester.

7.15 We published the results of this market research on 28 November 2007. It provides further insight into citizen and consumer views of, and preferences for, each of the potential uses of the digital dividend, particularly regarding the concept of and attitudes toward broader social value. It demonstrates that some views are reasonably robust over time, and where they are not, we have reconsidered the weight that should be placed on the evaluation of certain uses.

7.16 As found in the 2006 quantitative and qualitative market research, the 2007 research shows that no single use commands overwhelming support in terms of the personal or societal value that it generates. Figure 6, taken from the 2007 quantitative research, shows the percentage of participants who ranked each use first or second.

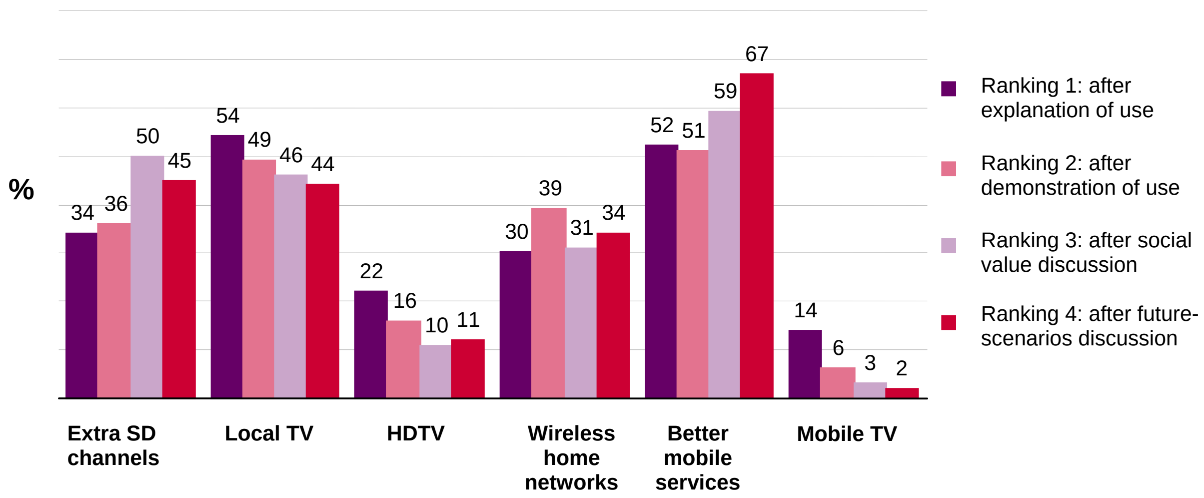
Figure 6. Ranked importance of uses: percentage ranking each use first or second



7.17 All uses were popular with some people. Even mobile television, ranked lowest on average, was rated in the top two from a personal perspective by 10% of participants.

7.18 Figure 7 is taken from the 2007 qualitative research and shows the proportion of participants who ranked each use first or second. It shows how rankings changed over the course of the day when participants considered the value to society of each of the uses. Participants were consistent in their views of which uses had value to society, with DTT services in HD and mobile television receiving low social rankings throughout the day. Improved mobile phone and mobile broadband services started out at a similar level to local television in terms of value to society but were clearly considered to be the most socially valuable of all the uses by the end of the day's discussions. Extra DTT services in SD were also considered to have higher value to society after discussion, ending at a similar level to local television, with wireless home networks falling just behind.

Figure 7. Ranked importance of uses: citizen perspective



Relevance of this source of evidence

7.19 The market research is relevant to our assessment of market failures as it helps to inform our consideration of whether some uses generate significantly more broader social value than others. The market research is also relevant to our assessment of the likely demand for spectrum for each of the uses.

7.20 Given the nature of this research, including the complex nature of the questions asked, the difficulties respondents face in answering hypothetical questions about new services and the limited sample size relevant to qualitative analysis, the results should be interpreted with care. The results should be considered as broadly indicative of differences in rankings of services rather than as precise estimates.

7.21 The market research evidence is also only one part of the story and cannot be relied on in isolation. Such research only reflects opinions at the time it is undertaken. Our assessment of market failure risk must be forward looking. Much of the digital dividend will not be available for new use until 2012—some five years from when the market research was conducted—and is likely to be used for many years after that.

7.22 Therefore, while the market research can help to inform our assessment of the relative value of the different uses today, our assessment of the market failure risk needs to predict how this value might evolve over time.

Economic modelling

7.23 The economic modelling set out in the DDR consultation document related principally to understanding the elements of total value associated with each potential use of the digital dividend. We worked with consultants to develop models for a number of these uses: mobile television, DTT services in SD and HD, local television, PMSE and mobile broadband. Within this last use, we considered both services based predominantly on the delivery of data ("data-centric") and services that involve more of a mix of voice and data ("voice and data"). The consultation document referred to these services as mobile broadband and mobile communications respectively. However, as our understanding of mobile services likely to be deployed in the digital dividend has grown, we no longer feel that these descriptions accurately capture the nature of the services modelled.

7.24 This modelling allowed us to estimate ranges for producer, consumer and external value.[36] Annex 8 discusses our approach to identifying these ranges. Our approach to identifying external value is based on the results of our qualitative and quantitative market research. The assessment of incremental external value should be treated with particular caution. These sources of value are inherently difficult to quantify, and there are a number of reasons why these results may be poor indicators of the actual level of external value. For example, some of the services are new, and hence it would be difficult for individuals to assess their broader social value. In addition, it can be difficult for individuals to appreciate fully the value a service generates for society. However, taking these difficulties into account, this analysis can help us to assess whether there are likely to be significant differences in the relative level of broader social value generated by the different potential uses of the digital dividend.

[36] These results are based on the difference in the importance and rankings of services on a societal basis compared to a private basis. It is likely that much of this is due to the presence of broader social value. However, some of this difference could be due to other forms of external effects, such as impacts on the UK economy and competitiveness.

7.25 Our modelling also involved developing a wide range of plausible future scenarios and counterfactuals and included work to understand how different combinations of use might affect values for both individual uses and the digital dividend as a whole.

7.26 The models take account of the availability of alternative ways of delivering the same services. The values are therefore incremental (i.e. the gain that comes from using the digital dividend rather than some other likely means of delivering the service).

7.27 We have reviewed and updated our modelling to take account of market developments. We have revised our findings in some cases, but this has not changed our overall assessment of the value to society of the digital dividend. We have also adapted the modelling to estimate the opportunity costs of forms of intervening. That is, we have developed indicative estimates of the impact on the value of the digital dividend if spectrum were reserved for specific uses.

7.28 When considering the results, it is important to keep in mind the difficulties this type of analysis faces. The high level of uncertainty and the complexity of some of the inter-relationships between services mean that this type of modelling can at best provide an order of magnitude assessment of value. The figures presented below should therefore not be interpreted as precise estimates. In particular, it would not be appropriate to compare the value of a service with the opportunity cost of its spectrum use and conclude that it should or should not use spectrum. At best, these results can only be used to provide an indication of whether the value of a service and the opportunity cost of its use of spectrum are of a similar order of magnitude.

7.29 Table 2 shows the updated results of our modelling work. Although there have been market developments, these have generally only suggested minor amendments to our estimates of the range of producer and consumer value that might be generated by likely uses of the digital dividend. (Note that these are not estimates of auction proceeds.) This is because our original modelling work was based on a wide range of different potential future scenarios to reflect the uncertainty facing many of the uses.

Table 2. Summary of results of economic modelling by service

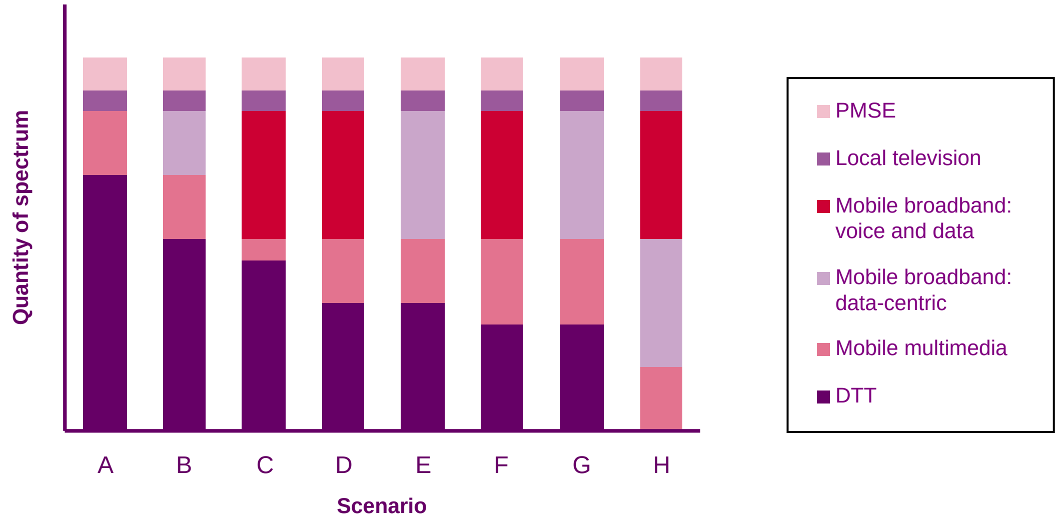
Service	Range of producer and consumer value (NPV over 20 years in £bn)[a]	Range of spectrum requirements (total for this service)	Indicative range of external value as a % of producer and consumer value
Mobile multimedia	0.3-3	8-48	Up to 5%
DTT in SD	0.5-3	24-112[b]	Up to 10%
DTT in HD	1-3.5	24-112[b]	Up to 5%
Local television	0.05-1	8[c]	Up to 10%
PMSE	0.15-0.5[d]	8 (cleared) Up to 256 (interleaved)	N/A
Mobile broadband (data-centric)	1-2.5	30-60	Up to 15%
Mobile broadband (voice and data)	0.5-2	10-64	Up to 15%

a Figures above £1bn are rounded to the nearest £0.5bn.
b. Using a multifrequency network.
c. At each location, local television could use either cleared or interleaved spectrum.
d. May understate the true value. Annex 8 discusses the reasons for this.

7.30 Annex 8 discusses the market developments reflected in these numbers.

7.31 We have also updated our estimates of the aggregate value of the use of the digital dividend. These estimates are based on the aggregate producer and consumer value. This has involved revising our illustrative scenarios to ensure these are consistent with our latest views on the range of likely uses of the spectrum. Figure 8 sets out the new scenarios.

Figure 8. Aggregate value of illustrative combinations of use of the digital dividend



7.32 The new set of scenarios reflect some changes. First, the proportion of the digital dividend illustrated as being used by mobile broadband is greater. This is due to a greater confidence that these services could make use of the spectrum and a consequently increased interest from providers of these services. The amount of spectrum illustrated as being used by mobile multimedia services is somewhat smaller in response to a number of consultation responses indicating that a large number of video streams can be carried in a single channel, so market needs might be reduced. Similarly, the spectrum used for DTT is lower in some scenarios, partly due to our proposals to improve DTT capacity within the spectrum reserved for it.

7.33 Although there are some substantial changes in some of the combinations comprising the scenarios above, this has not significantly changed the aggregate value figures that were stated in the DDR consultation document. A value to producers and consumers of approximately £5-10bn (NPV over 20 years) is still our best estimate of aggregate value.[37] Our analysis of external value suggests that externalities could increase this by up to 10% in total.

7.34 Our modelling work has also involved developing illustrative estimates of the magnitude of the opportunity cost of intervening. This requires hypotheses about spectrum use in the absence of intervention. Annex 8 discussed these hypotheses and our approach to modelling opportunity cost more generally.

[37] Note that simply summing the individual service by service results will not result in the same aggregate value. This is in part because these results are based on each service acquiring all the spectrum it needs. The aggregate value scenarios take into account that this is not going to be possible in practice owing to excess demand for spectrum. Our approach to assessing the aggregate value of the digital dividend is discussed in annex 8.

7.35 Table 3 describes the ranges of estimated economic value (producer and consumer value) for cleared spectrum. The economic value grows as more channels are removed by intervention. In reality, not all channels have the same value because their use will be subject to different technical constraints.

Table 3. Estimated opportunity cost of removing cleared spectrum by intervening (NPV over 20 years)

Number of channels	1	2	3	4	5	6
Low economic value	£100m	£200m	£400m	£700m	£1bn	£1bn
High economic value	£400m	£700m	£1bn	£1.5bn	£2bn	£2.5bn

7.36 These results indicate that the opportunity cost of one channel is less than one 15th of the aggregate value of the digital dividend. This is for two reasons:

- the aggregate value estimate includes the value of interleaved spectrum as well as cleared spectrum; and
- more importantly, the opportunity cost of one channel is the economic value of the lowest value channel. Therefore, as the number of channels lost through intervention increases, the opportunity cost per extra channel will also tend to increase.

7.37 For interleaved spectrum, we have estimated the opportunity cost by assessing the value that might be lost if some of the most valuable sources of demand are precluded. This work identified that precluding the most valuable uses could have an opportunity cost of up to £400m per channel (NPV over 20 years). However, once demand for two of the high value potential uses is satisfied, the opportunity cost of a further channel falls to a high of £50m per channel.

Relevance of this source of evidence

7.38 Our modelling work plays two roles in our market failure assessment:

- it helps us to understand the magnitude of the total value that might be lost if a market failure were to result in one of the uses not emerging or being significantly constrained; and
- it helps us to understand the magnitude of the opportunity cost involved in intervening. This is because it allows us to assess the value that might be lost if we intervene to facilitate one use of the spectrum at the expense of another. The assessment of opportunity cost is important in helping us to identify how significant a market failure needs to be to justify intervention.

7.39 The estimates of opportunity cost do not give us a guide to the size of potential costs due to dynamic effects such as reduced flexibility and weakened incentives for efficiency. These potential regulatory failures need to be considered in addition to opportunity costs.

Secondary research

7.40 For the DDR consultation document, we commissioned and published research concerning possible external value (meaning broader social value and other external value) that is incremental to, i.e. causally related to, use of the digital dividend. There may be significant broader social value associated with certain potential uses in general, such as broadcasting, but the relevant question for the DDR is the extent to which use of the digital dividend will result in additional broader social value. The research was intended principally to help us understand whether significant incremental external value existed for any of the uses in ways that differed from private value and producers' willingness to pay for spectrum.

7.41 The research took two approaches:

- top down, using the 2006 market research results to quantify aggregate external value; and
- bottom up, using those results to build up the elements of external value for uses based on categories of broader social value.

7.42 The research also used existing secondary research, principally relevant academic articles and our own reports and studies, as well as interviews with stakeholders.

7.43 The top down approach found only relatively modest differences between private and total values, with no significant differences across the uses studied. The bottom up approach tended to suggest that, although significant absolute broader social value might be associated with some uses (e.g. PMSE, more DTT services in SD and mobile broadband), the incremental broader social value associated with using the digital dividend was relatively modest.

7.44 We have reconsidered the secondary research in the light of the 2007 market research, new evidence and recently published studies. In particular, several relevant academic and other journal articles relating to consumer and citizen interests in broadcasting and communications services have been published. The views and conclusions expressed in them broadly accord with material already considered for the secondary research, so the conclusions remain materially the same.

Relevance of this source of evidence

7.45 The secondary evidence helps to assess the incremental broader social value that might be generated by uses of the digital dividend. This is important in assessing the size of the market failure risk.

7.46 The secondary evidence also helps when predicting how the broader social value generated by some uses might change over time. This is because this research sought to identify the drivers of broader social value associated with each of the services. Hence, consideration of how these drivers might change in the future can provide some pointers for how broader social value might also change.

Technical analysis

7.47 Any new use or user of the digital dividend will have to ensure that its services do not adversely effect the reception of existing licensed services using the spectrum reserved for DTT. Hence, new uses will be subject to a range of technical considerations and constraints, although these will not affect all uses or combinations of use equally because of their varied nature.

7.48 We published several technical reports and analyses alongside and after the DDR consultation document. These set out our initial findings on technical issues, noting, for example, that one way of providing local television—the add/drop option (see paragraph 7.110) —would potentially be costly.[38] Technical analysis also provides useful information to guide the assessment of the total value generated by uses of the digital dividend. For example, for some uses (particularly mobile services), these frequencies allow high coverage at relatively low cost when compared to other suitable frequencies. The technical analysis helps us to understand the magnitude of this advantage when compared to alternative spectrum.

7.49 We have continued to assess technical evidence relating to spectrum use by commissioning further investigation into the compatibility issues between the different types of potential services that might use cleared spectrum. This highlights that the operation of a new service in cleared spectrum can cause interference to other new services (possibly using different technology or network designs) operating in neighbouring channels. However, the technical research shows that this can be mitigated with careful network design and frequency separation.

7.50 The research also suggests that further improvements in the compatibility between different types of use could be gained by adopting better transmission and receiver filter performance compared to what was assumed in the earlier technical reports published with the consultation. The use of these improved filters could also improve the efficient use of cleared spectrum and simplify network deployment.

7.51 The technical analysis that we have carried out since the publication of the DDR consultation document consists of:

- a series of measurements to quantify the impact of interference from a number of potential service types into DTT receivers. This offers an understanding of the performance of real digital receivers in the market today in the presence of interference from a variety of sources;

- a series of measurements to assess how different types of service using the digital dividend may affect the operation of other services. These were carried out using existing equipment where possible to understand the tolerance of each potential type of use to interference from another type of use;

- an international interference assessment to provide an understanding of the potential incoming interference from neighbouring countries operating broadcast services in cleared spectrum and the maximum allowable outgoing interference levels to those countries. Interference levels are plotted geographically on the basis of agreements with each country;

- the feasibility of providing an IMT-2000 mobile voice and data service within UHF bands IV and V. This covers a number of different aspects, including compatibility with DTT, spectrum requirements and potential ways to overcome interference problems through network and antenna design;

- channel 36 issues. This models the potential interference and issues with a potential mobile television service in channel 36 operating before the existing adjacent channel analogue television services switch over to digital;

- an assessment of how the operation of mobile television services using DVB-H could cause interference into analogue PAL television services using an adjacent channel. These measurements were carried out to test the interference tolerance of typical existing analogue television receivers from a new mobile television

[38] www.ofcom.org.uk/radiocomms/ddr/documents/tech_tv/.

service and were specifically commissioned to evaluate the use of channel 36 for such services in advance of DSO;

- interference analysis of mobile WiMAX with respect to DVB-H and DVB-T systems. This investigates compatibility when operating a WiMAX service in spectrum adjacent to DTT or mobile television. The report determines the frequency separation and potential for interference between the services;

- an investigation of the availability of assignments within interleaved spectrum that would be suitable for local television at 71 main transmitter sites; and

- a study of PMSE. This looks at technical interference issues for analogue and digital wireless microphones using interleaved spectrum following DSO.

7.52 Further research and analysis is informing a set of technology neutral licence conditions to enable potential uses of cleared and interleaved spectrum to operate without undue interference to or from adjacent uses.

7.53 Annex 9 lists and summarises the technical reports that we are publishing alongside this statement.

<u>Relevance of this source of evidence</u>

7.54 This evidence is relevant to our market failures assessment as it informs our assessment of the likely uses of the digital dividend and hence the uses that need to be assessed in relation to the risk of market failure.

7.55 This evidence also helps to inform our analysis of the opportunity cost of intervening. This is because it provides information about the coexistence of services and hence can inform an assessment of the impact of intervening in favour of one use on the usability of the remaining spectrum for other uses.

7.56 Finally, this evidence also helps us to understand what technical constraints might be required to enable the full range of potential services to operate within cleared and interleaved spectrum. It will help us to prepare our forthcoming consultations on detailed award design.

Consultation responses

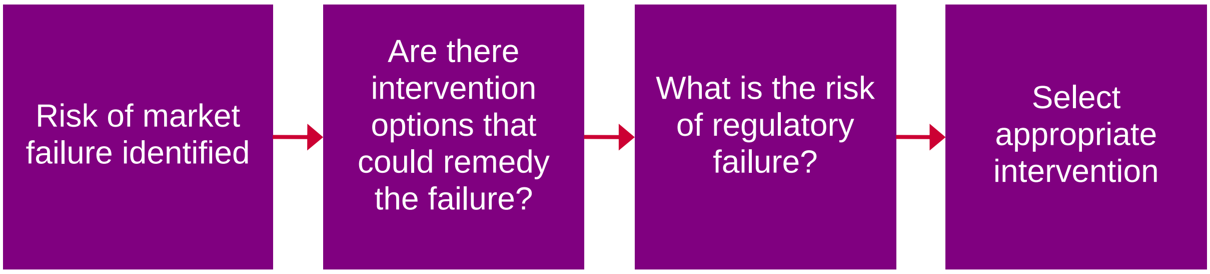
7.57 Many responses to the DDR consultation document commented on the principle or application of our total value framework, particularly concerning broader social value. Some respondents provided new evidence concerning the relative value of different uses of the digital dividend and how these might develop in the future.

7.58 We have carefully considered responses and assessed new evidence. The responses received in relation to each of the market failure assessments are summarised below. Our reapplication of the framework for identifying whether there is a case for intervening takes these into account.

Assessing the case for intervention

7.59 Figure 9 sets out the process we have followed to assess the case for intervening in a market led award for each of the likely licensed uses of the digital dividend.

Figure 9. Process for applying the total value framework



PMSE

7.60 PMSE is an existing significant use of interleaved spectrum. It makes a major contribution to the UK's social, cultural and economic well being. It consists of a wide and diverse community, both professional and amateur, including broadcasters, theatres, large event organisers, schools and churches. UHF bands IV and V are used for a number of different PMSE applications, primarily wireless microphones for both professional and community use but also in ear monitors and talkback systems. Channel 69, which is not used for DTT, is also available for PMSE use.

7.61 Professional PMSE users are typically broadcasters, commercial theatres and event organisers. They require assured quality of service to guard against interference from other users. They use this spectrum because this is where the equipment in which they have invested operates. Community PMSE users, such as churches, local theatres, pubs and schools, are also driven by their investment in equipment that operates in this spectrum.

7.62 The DDR consultation document proposed auctioning interleaved spectrum to promote a flexible market led approach that would not restrict or limit the use of the spectrum. Because we recognised that the transition to accessing spectrum via market mechanisms could pose a significant risk of disruption to PMSE use of this spectrum, we proposed ensuring continued access until at least the end of 2012, when DSO ends. We also proposed making some or all of channel 69 available for use on a licence exempt basis given that community users typically do not require their use to be coordinated with others.

7.63 Many respondents argued that a fragmented PMSE sector could not compete successfully at auction and/or that a longer period of transitional access to interleaved spectrum after DSO was needed. They also argued that channel 69 was important for professional users who require coordinated, interference free access across the UK and so should remain available on a licensed basis.

7.64 We reflected on these responses and on 20 June 2007 published a further consultation document on future spectrum access for PMSE.[39] This recognised that a number of factors could make it difficult for the sector to engage in a market for spectrum access quickly and effectively. It identified four objectives in designing future arrangements for PMSE use of interleaved spectrum:

- avoiding disruption to PMSE users that adversely affects their ability to provide a wide range of services to citizens, consumers and business customers;

- facilitating the participation of PMSE users in a market led approach to spectrum, particularly to provide them with incentives for efficient use;

[39] www.ofcom.org.uk/consult/condocs/pmse/pmse.pdf.

- promoting the optimal use of the spectrum in relation to all potential uses and users over time; and

- avoiding the risks of regulatory and market failure.

7.65 The PMSE consultation document set out six options for how the PMSE sector could access interleaved spectrum in the future. They are summarised in table 4 and explained in more detail below.

Table 4. Options for future PMSE access to interleaved spectrum

Status quo		Transition			No intervention
Option 1	**Option 2**	**Option 3**	**Option 4**	**Option 5**	**Option 6**
Status quo	Status quo with AIP	Beauty contest with AIP	Auction with additional safeguards	Auction with DDR safeguards	Auction without safeguards

7.66 Options 1 and 2 are described as status quo because these would involve essentially seeking to replicate the present approach to spectrum access for PMSE from DSO. These arrangements would continue for an indeterminate period, depending on future policy decisions. Under these options, PMSE users would use spectrum specified by us. They would do so via a band manager appointed by us, on terms and conditions specified by us. They would individually hold short term licences, with a maximum length of one year, and they would enjoy little or no security of tenure.

7.67 Option 2 would differ from option 1 through the application of AIP to the spectrum.

7.68 Option 6 is included for completeness only. It would involve auctioning interleaved spectrum with no transitional protection for existing PMSE users. We do not consider that this option meets our objectives. However, it is useful in illustrating the limiting case to the level of intervention.

7.69 Options 3 to 5 are described as transition because they involve a move to a market led approach that is phased over time, at greater or lesser speed and through varying types of measure to achieve that outcome.

7.70 We favoured options 3 and 4.

Consultation responses

7.71 We received 140 responses, most of which expressed concerns over some of our key proposals, in particular the widespread belief among PMSE users that they would be unable to take part in any market led approach to spectrum access.

7.72 The majority of responses, 92 in total, were expressions of support for a submission from the PMSE Pro-User Group, a representative body that set out its own proposals for future licensing of PMSE spectrum use. Annex 3 sets out the detailed responses that we received.

Our response

7.73 We continue to believe that we should address the risk of coordination failure currently faced by PMSE and, in doing so, should pay particular attention to how these transitional issues can be overcome, allowing PMSE users to access spectrum via market mechanisms in the longer term.

7.74 Our assessment of whether to intervene to resolve this market failure is informed by our assessment of its opportunity cost. Assuming we are able to award some interleaved spectrum in a form suitable for other uses (e.g. local television), our work suggests that the opportunity cost of resolving this market failure is plausibly at most £250m (NPV over 20 years). Annexes 2 and 8 explain our approach to identifying this indicative estimate. This level of opportunity cost is plausibly of a similar order of magnitude to the value that might be generated by using this spectrum for PMSE. Hence, we need strong evidence of the market failure risk in order to intervene and should be mindful of how our method of intervening can reduce regulatory failure risks.

7.75 We believe the evidence for market failure is compelling. As explained in our PMSE consultation, there are barriers to PMSE users engaging in a market at this time, and these barriers are sufficiently severe to suggest that a reasonable period of transition would be required to overcome them.

7.76 To identify which of the potential options for resolving the transitional coordination failure faced by PMSE users is most appropriate, we have given additional thought to the nature of the solution we need to meet our objectives and how we can mitigate the risk of regulatory failure.

7.77 We believe that this solution involves two key elements:

- to prevent undue disruption to PMSE users and provide an appropriate transition to a market led approach, hence avoiding a cliff edge, we need to ensure that prices for spectrum access increase toward market rates gradually and that users' ability to access spectrum is not suddenly reduced; and

- it is essential that the band manager has flexibility to respond to signals from PMSE users when setting prices and, where appropriate, to promote efficient spectrum use as this will help PMSE users to move to a market led approach and can also reduce the risk of regulatory failure in relation to this intervention.

7.78 To ensure that these elements are present in our solution, we have identified that the following will be required:

- the ability to exert some regulatory control over the prices PMSE users are charged during the transition period;

- the ability to provide PMSE users with some protection in relation to the amount of spectrum they are able to access during the transition; and

- the ability to ensure that the band manger has incentives to promote efficiency and to assist PMSE users in responding appropriately to market signals.

7.79 Given these requirements, our assessment is that the most appropriate option to bring this about is option 3 (a beauty contest with AIP). The benefits of an auction (e.g. option 4) are limited by the regulatory requirements we think are needed to manage the transition period. Annexes 2 and 3 set out the reasons for this. Section 8 sets out how we will implement it in the digital dividend awards. We believe that we can appropriately mitigate the risk of regulatory failure in relation to this intervention by ensuring that the band manager has incentives to promote spectrum efficiency and by ensuring that the transitional protection is time limited.

7.80 There are some practical benefits to choosing option 3 over option 4. It may be easier to extend to PMSE use of spectrum outside the digital dividend than an auction. These bands are different in their nature (many are managed by MOD) and their use (primarily supporting wireless cameras and other video links rather than wireless microphones and other audio links).

7.81 Figure 10 summarises the application of our analytical framework in reaching this conclusion.

Figure 10. Application of our analytical framework to PMSE

Risk of market failure identified →	Are there intervention options that could remedy the failure? →	What is the risk of regulatory failure? →	Select appropriate intervention
PMSE users face a number of barriers to their participation in a market led approach to spectrum, including: • they do not currently face incentives to use spectrum efficiently • transaction costs may be disproportionately high • information on value does not travel through the value chain These barriers are likely to be transitional rather then enduring	Options considered most likely to be effective at solving the market barriers/failures: • beauty contest with AIP for award to band manager, with intention to transition to market led approach over time • auction with additional safeguards for PMSE users	Assessing each option: • beauty contest—no market led determination of price; likelihood of inefficient initial allocation • auction with safeguards—risk that auction fails to secure efficient outcome given restrictions on use needed to provide transition for PMSE to market led approach	Particular difficulties for PMSE users point to some form of beauty contest that can facilitate a managed transition to a market led approach Based on our work on opportunity costs, we believe that these are plausibly of a similar order of magnitude to the benefits of intervening. However, we believe the evidence of market failure is sufficiently strong to warrant intervening and that the intervention chosen can appropriately mitigate the risks of regulatory failure

7.82 In relation to channel 69, this is heavily used by PMSE users because its availability across the UK allows travelling productions to use the same equipment and the same frequency plan at all venues. We also recognise the importance that PMSE users attach to the higher quality product that can be provided through licensing. We have decided that use of channel 69 should continue on a licensed basis. We will include channel 69 with the rights to be awarded to the band manager. Section 8 nonetheless addresses access to spectrum for users who do not require assurance of such high quality.

7.83 Shortly we will also publish detailed information on the availability of interleaved spectrum for PMSE after DSO.

7.84 Table 5 summarises our application of the total value framework to PMSE. Annex 2 sets this out in more detail.

Table 5. Application of the total value framework to PMSE

Market failure	Case for intervention	Conclusion
Transitional coordination failures	There is real risk of market failure due to coordination difficulties faced by these users during the transition to accessing spectrum via market mechanisms Given the severity of the problem faced and the difficulties PMSE users need to overcome to participate in a market for spectrum access, the most effective remedy involves taking an interventionist approach that restricts the use of spectrum and allows a managed transition to market mechanisms	We should intervene in order to resolve the transitional coordination failures faced by PMSE users This is likely to involve decisions about the use of some interleaved spectrum alongside regulatory intervention to manage the transition process and hence represents an interventionist approach
Community uses facing coordination failures	Community users face coordination failures that are likely to be more enduring than those faced by professional users Community users also use spectrum in a way which makes licence exemption a suitable approach to their spectrum access	We should consider what spectrum can be made available for community users on a licence exempt basis

Local television

7.85 Many forms of content deliver broader social value. It is because of this that we have intervened in the past, most notably in the PSB Review and our focus on the provision of content by the BBC, ITV, Channel 4 and Five. In addition to the content provided by the PSBs, other forms of content could deliver broader social value. Local television is one of these. Content focused on communities of interest with a citizenship dimension could be another.

7.86 Our 2003 PSB Review and our Digital Local report,[40/41] as well as the DDR consultation document, all identified local television as a service with the potential ability to deliver public service benefits (i.e. broader social value). Indeed, Digital Local referred to such services as being capable of creating “significant citizen and consumer benefits” and as “a potentially important element in the future PSB mix.”

7.87 Digital Local identified a number of public purposes, similar to the broader social value categories we identified in our total value framework that might be delivered by local television. These were:

- informing ourselves and others and increasing our understanding of the world through news, information and analysis of current events and ideas, with particular focus on issues relevant to our locality;
- stimulating our interest in and knowledge of arts, science, history and other topics, particularly those relevant to our locality, through content that is accessible and can encourage informal learning;
- reflecting and strengthening our cultural identity, particularly that based on shared local identities, through original programming at local level, on occasion bringing audiences together for shared experiences;

[40] www.ofcom.org.uk/tv/psb_review/.
[41] www.ofcom.org.uk/tv/psb_review/digital_local/.

- making us aware of different cultures and alternative viewpoints through programmes that reflect the lives of other people and other communities, especially those within our local area; and
- supporting and enhancing our access to local services, involvement in community affairs, participation in democratic processes and consumer advice and protection.

7.88 Local television may be identified as a service likely to serve a closely defined geographic area such as a city, a local authority district or a smaller area (e.g. a neighbourhood or housing estate). It may be operated on a wholly commercial basis, as a not for profit community model or as a combination of both.

7.89 Local television is a common element of the television environment in Europe and North America. It has developed because of various factors, including high cable penetration in some countries (Germany and the Netherlands), direct subsidy (Belgium and Germany), relaxed terrestrial licence regimes (Italy and Spain) and mature market consolidation and mergers (Canada and the US).

7.90 In the UK, examples of local television include Channel M in Manchester (a commercial operation backed by Guardian Media Group and based on a North American “city TV” formula), MATV in Leicester (a commercial operation targeting the city’s South Asian community) and NvTv in Belfast (a not for profit community model funded by Northern Irish arts, education and training bodies).

7.91 All these services are currently broadcasting via analogue terrestrial transmission under Restricted Service Licences (RSLs). Channel M and MATV are also available on other platforms, such as cable and satellite. There are a limited number of cable only operations, including Channel 7, which launched in January 1998 and broadcasts from studios in Immingham onto the Virgin cable network. This service is available to around 70,000 people across north and northeast Lincolnshire.

7.92 Most existing and potential local television operators see access to and visibility on the DTT platform as desirable for the future success of their channels. To support this argument, they point to the failure of most previous ventures based solely on cable or satellite television and to the paucity of Internet television examples.

7.93 The DDR consultation document identified local television as a likely use of interleaved spectrum. It recognised that demand for that spectrum was likely to come from operators in different locations and that there was a risk of coordination failures preventing them from reflecting their value for spectrum if they had to bid for UK wide licences. We therefore proposed awarding geographic packages of interleaved spectrum, based on main transmitter sites, suitable but not reserved for local television. These packages would be awarded by auction. Subject to further technical research, we suggested that there could be 40 or more, perhaps up to 100 such packages.

7.94 The consultation document concluded that it was not necessary to reserve spectrum exclusively for local television to reflect the broader social value that it might generate. The evidence for broader social value was suggestive rather than clear cut, and direct funding was the best way to realise any that did exist.

Consultation responses

7.95 In total, we received 244 responses in relation to local television. Although the majority of respondents opposed our proposals to auction interleaved spectrum in packages suitable for local television services, there was almost an equal split between those in favour of more intervention in support of local television (90) and those against (80). Around 20 responses from a wide range of stakeholders, including our advisory committees, broadcasters, telecommunications operators, respondents with an interest in low power use and local television operators plus a small number of individuals, supported our proposals.

7.96 Among those who advocated less intervention were proponents of using interleaved spectrum for other services, such as PMSE and DTT services in HD. Others suggested that, because local television has had limited success in the past, there was little demand for local television services and other platforms, such as the Internet, could be used to provide local services. Others suggested that, to reflect the broader social value of local television, a band manager should be used to allocate spectrum for both local television and PMSE. A number of local television operators felt that spectrum should be specifically reserved for local television.

7.97 Respondents generally agreed with our assessment of the risk of coordination failures but disagreed with our assessment of the need to reserve spectrum for local television to realise broader social value. They raised a number of specific points:

- many suggested that broader social value was unlikely to be reflected in the bids that local television operators could make at auction;
- many also felt that we should carry out further work to better determine the broader social value generated by local television and consequently reserve part of the digital dividend exclusively for local television operators;
- the Community Media Association did not think that our economic arguments were compelling because broader social value is difficult to quantify; and
- consumer bodies called for broader social value generated by local television to be factored into the auction process. One suggested that this could be done by reserving spectrum for community services via a community band manager, which would allocate spectrum between competing uses such as DTT, community mobile broadcasting and wireless broadband.

7.98 Some respondents argued that we should act to ensure that local television is available nationwide and pointed out that this would not be achieved through the use of interleaved frequencies. They called for capacity to be reserved for local television on new or existing DTT multiplexes. Local services would be inserted on the national multiplexes in areas where there was demand using add/drop technology.

Our response

7.99 Consultation responses and our 2007 market research both point to there being significant interest in local television. This supports our position that it is important to allow this use to participate in the award of the digital dividend on an equal footing.

7.100 It is also clear that local television, as well as many other potential uses, faces a number of challenges. Our economic modelling suggests that the business case for local television on DTT faces some difficulties, for reasons including:

- the cost of delivering high quality content. We understand that this is important if viewers are to watch local services. However, the costs involved are significant. When broadcasting on the DTT platform, these are combined with the high cost of acquiring access to multiplex capacity;

- the degree of competition it faces from other forms of local media; and

- viewer demand for limited local television content. Our market research suggested this could be only an hour or two a day, which will limit the advertising revenues that can be generated and may mean that demand is insufficient to warrant a dedicated television channel.

7.101 At the same time, DTT is by no means the only platform on which local content can be delivered. Digital Local identified the enormous potential of broadband Internet to meet local public service purposes, including through interactivity. It is clear that this potential has not yet been fully realised, but an ever growing number of providers are now using the Internet to provide local news and information, including in video form. These providers include newspapers, local authorities, community groups and some commercial Internet television operators.

7.102 The development of next generation broadband access, with improved technical performance, is likely to make broadband television both more accessible and more watchable in the home. ITV Local has already launched a fully interactive television-type service throughout England and Wales, using linear and on demand services side by side and building on the broadcaster's regional news services for ITV1.

7.103 We recognise the concerns of some in the local television community over the suitability of the Internet as an alternative delivery platform. However, we believe that the role of the Internet in delivering video content is evolving quickly, and by the time the digital dividend spectrum is widely available, the use of this platform in delivering this type of content is likely to be increasingly commonplace.

7.104 In its report on public service content, the House of Commons Select Committee on Culture, Media and Sport considered the value that might be generated by providing local content and the need to support this use to allow it to be provided on the DTT platform. The Committee concluded that:[42]

> We note the enthusiasm of some witnesses for the potential for local television and the view that the Government needs to take action to support the provision of local content. However, while we do see some value in local content, we are not convinced of the need to intervene to support local television, particularly by giving away spectrum for broadcasting on digital terrestrial television. If providers want to offer local television services, we believe that more targeted delivery platforms, such as broadband, are more appropriate.

7.105 We have carefully considered the arguments for reserving spectrum for local television, but we have concluded that this would not be an appropriate response for a number of reasons. This does not mean that we think that local content is of low value. We understand that this use could generate significant value. However, there are a number of reasons why we should not intervene in the award of the digital dividend just because of this.

[42] www.publications.parliament.uk/pa/cm200708/cmselect/cmcumeds/36/36i.pdf.

7.106 First, the opportunity cost of local television displacing other uses could be relatively high. As discussed in annexes 2 and 8, our modelling work indicated that this could be as high as £400m (NPV over 20 years). This is plausibly of a similar order of magnitude to the value that could be generated by using this spectrum for local television. When this is the case, we need strong evidence of a market failure risk in order to justify intervening.

7.107 Second, while there is evidence of broader social value from this use, this alone is not sufficient evidence of market failure. It is differences in the magnitude of broader social value generated across uses of the digital dividend that is a key driver of market failure. The market research indicated that almost all uses generated broader social value and that the level generated by different uses was comparable.

7.108 Third, there are reasons why the incremental broader social value generated by the use of the digital dividend may not be as great as expected. Using the digital dividend rather than alternative on demand delivery mechanisms for local television may not generate the most value for society if viewers' demand is for only one or two hours of programming a day. And delivering local content on other platforms, such as the Internet, may increasingly allow the broader social value of local content to be achieved without access to this spectrum.

7.109 Finally, intervening in the award of the digital dividend is unlikely to be a solution to the problems faced by local television operators. Simply reserving spectrum would do little to improve its business case given the high costs involved in producing television content that viewers want to watch and the challenging business model of local television in the UK. Even if spectrum were reserved for local television, we would expect to charge AIP to reflect the opportunity cost of this use. It is likely that a failure by local television to acquire spectrum at auction would be due to that challenging business case. This is the problem that needs to be addressed, and in instances where there is a broader social value case for local television, it is better addressed through direct funding rather than by specifically reserving spectrum.

7.110 Under add/drop arrangements, local television operators would agree with a multiplex operator to remove a certain service in an identified area and replace it with the local service. We believe that the use of interleaved spectrum for local television presents a more flexible and credible mechanism for delivering local services. Although we recognise that add/drop is a technically feasible option on either an existing or additional national multiplex, the proposal suffers from a number of fundamental disadvantages that mean that we do not support its implementation:

- the opportunity cost of intervening to reserve one or more slots on a national multiplex is likely to be very high;
- add/drop requires the transmission of core signal across the network and national coordination of all local television operators. Capacity would remain unused in areas where local services are not viable; and
- local television operators would need to share the cost of national capacity. This raises significant coordination difficulties similar to those set out above.

7.111 We have therefore decided that we should address only the risk of coordination failures faced by local television in bidding for the digital dividend. Section 8 sets out how we will do so in the digital dividend awards. Figure 11 summarises how we have applied our analytical approach to reach this conclusion. Annex 2 sets out the analysis supporting this assessment in more detail.

Figure 11. Application of our analytical framework to local television

Risk of market failure identified	Are there intervention options that could remedy the failure?	What is the risk of regulatory failure?	Select appropriate intervention
Coordination failures: if local television operators need to bid together for UK-wide licences, they may not be able to coordinate a bid that accurately reflects the value they generate	Two main options: • tailor auction packages—can address coordination failures directly through geographic packages • reserve spectrum—could solve coordination failures but would do so by excluding others Other options unlikely to be effective for this type of market failure	Tailor auction packages: some risk of regulatory failure as could unduly distort the auction outcome if favours local television operators too much Reserving spectrum: likely to be subject to high regulatory failure risk as does not allow market to test whether local television is best use and given likely reduction in future flexibility of use of spectrum	Tailor auction package: the best intervention option for resolving the coordination market failure The opportunity cost of intervening is plausibly of a similar order of magnitude to the benefits. However, we think intervening is justified as the evidence of market failure is sufficiently strong and because the intervention chosen allows the market to test whether local television is the best use and, hence, whether the opportunity cost is worth incurring. This significantly reduces the risk of regulatory failure

7.112 Table 6 summarises our conclusions in relation to each of the key market failure risks considered for local television.

Table 6. Application of the total value framework to local television

Market failure	Case for intervention	Conclusion
Coordination failures	There is evidence to suggest local television operators would face significant transaction costs which would prevent them from effectively coordinating in a bid for UK wide packages This can be resolved via auction design and packaging, which reduces the risk of regulatory failure relative to taking an interventionist approach. This is an important consideration given the potential magnitude of the opportunity cost	Remove coordination problem via packaging Consistent with market led approach
Broader social value	The evidence of incremental broader social value generated by this use of the digital dividend compared to other uses is insufficiently strong to warrant intervening in the award of the digital dividend. This is due not least to the availability of alternative delivery mechanisms (e.g. the Internet) and the magnitude of the opportunity cost and risks of intervention If intervention is required to secure broader social value, the best option is direct funding. This option would not be precluded by a market led approach	No intervention in DDR

Advertiser funding business model	Some respondents suggested that the use of an advertiser funding business model by local television operators results in a market failure Annex 2 sets out our assessment of this. It identifies that there are difficulties with the advertiser funding business model but that these do not constitute a market failure	No intervention in DDR

DTT

7.113 The DDR consultation document assessed the potential for market failure to distort the acquisition of spectrum to provide additional capacity on the DTT platform for services in both SD and HD. This involved considering a number of market failure arguments common to both services and some additional arguments relevant only to HD. It led us to propose not intervening in the award of the digital dividend to reserve spectrum for DTT services, whether in SD or HD, but still to ensure that the packaging of spectrum was suitable for use by DTT services.

7.114 We received 516 consultation responses, including 443 from individuals, regarding our proposals for DTT. The vast majority of respondents voiced concerns about whether our proposals would preclude DTT services in HD, although a vocal minority of organisations and some individuals supported our proposals for a market led approach in this area. A small minority of responses also specifically sought additional capacity for DTT services in SD.

<u>SD</u>

7.115 An important factor that influenced our proposal in the DDR consultation document was the assessment of incremental broader social value that might be generated by additional PSB channels in SD. We did not consider it likely that this would be significant given the amount of existing spectrum already used to deliver PSB channels in SD.

7.116 We also identified that there was a risk of capital market failure for the BBC and Channel 4 because of the borrowing restrictions they face.

Consultation responses

7.117 One of the key themes raised in responses was that we failed to take account of channels that are not PSB in nature but have a community/citizen focus. Respondents argued that our assessment did not consider the incremental broader social value that these channels, which are currently limited in number, could generate. For example, following consultation, we received over 600 emails from individuals asking us to set aside spectrum for Teachers TV.

7.118 Responses generally supported our assessment of the capital market failure risk.

Our response

7.119 We continue to consider that there is a potential capital market issue associated with the BBC and Channel 4. Figure 12 sets out our assessment of applying the analytical approach to this.

Figure 12. Application of our analytical framework to DTT

Risk of market failure identified	Are there intervention options that could remedy the failure?	What is the risk of regulatory failure?	Select appropriate intervention
The borrowing restrictions faced by the BBC and Channel 4 act as a regulatory barrier to their ability to raise capital in order to bid for spectrum for services in both SD or HD In relation to all other potential bidders (e.g. ITV and Five), there does not appear to be a strong case for capital market failures (availability of funding linked to strength of business case)	Options for resolving: 1. remove the regulatory barriers 2. adjust the auction design to allow phased payments (reducing the need to raise capital upfront) 3. intervene in award, e.g. by reserving spectrum (unlikely to be justified given the scale of the problem)	Assessing each option: 1. remove barriers—likely to be effective and have limited knock-on effects 2. adjust auction design—results in risks of default and potential distortion in behaviour 3. intervene in award—imposes significant costs on other users of the digital dividend	Best option looks to be relaxing the regulatory barriers that limit the ability of the BBC and Channel 4 to raise funds This would allow the market to test whether DTT is the best use and, hence, whether the opportunity cost of intervening to level the playing field for this use is worth incurring

7.120 Our conclusion in relation to the capital market issues faced by the BBC and Channel 4 as a result of their borrowing restrictions is that these have the potential to result in a market failure. The best option for resolving these would be to consider if the restrictions should be removed. This issue is a matter for the Government, the BBC and Channel 4.

7.121 In relation to our assessment of broader social value, as indicated above, our earlier analysis focused on using the digital dividend to provide additional PSB channels in SD. We have therefore considered carefully how other, non-PSB channels might generate broader social value and hence whether this should be reflected in our approach to awarding the digital dividend.

7.122 One important piece of additional evidence is our 2007 market research. This sought to identify whether DTT services in SD with a community/citizen focus generated significant broader social value. This work suggested that they could.

7.123 We have considered whether this could result in a market failure in the award of the digital dividend. This analysis identified a number of reasons why we do not believe this market failure risk to be significant and, additionally, why reserving spectrum for this use would not be an appropriate response:

- the risk of market failure faced by this use is not access to spectrum but rather access to multiplex capacity. Given the availability of existing multiplex capacity and the possibility that this will increase over time (see below), it is unlikely that intervening in the award of the digital dividend will generate significantly greater benefits than resolving the market failure in accessing existing multiplex capacity;

- while this use is likely to generate broader social value, it is not disproportionately greater relative to the total value of DTT services in SD than the broader social value generated by a number of other potential uses that it could displace (e.g. local television and mobile broadband). Hence, it is unclear that there is a significant risk of market failure in awarding the digital dividend due to the presence of broader social value generated by this use;

- if the content provided by some providers is of limited duration and/or niche appeal, it might be appropriate to use alternative delivery mechanisms to traditional linear television, such as on demand services downloadable to personal video recorders (PVRs) or via broadband. This may reduce the incremental broader social value generated by using the digital dividend to deliver this service; and

- the points made above all suggest that the market failure risk in relation to this use in the award of the digital dividend is unlikely to be significant. The first and third points also suggest that, if a broader social value market failure were to be a problem, intervention in the form of direct funding, rather than via setting aside spectrum, would be the best option for resolving it. Direct funding could resolve the market failure in relation to existing multiplex capacity and would allow potential content providers to decide between delivering their services on the DTT platform or through alternatives such as the Internet, allowing them to identify the best value outcome for citizens and hence to maximise the total value generated by their service.

7.124 The opportunity cost of intervening to provide an additional DTT multiplex for community/citizen focused content, as discussed in annexes 2 and 8, could be £1-2.5bn (NPV over 20 years). This suggests that we would need strong evidence of market failure to justify action and that we should pay particular attention to encouraging the most effective means of resolving any market failure, such as through funding decisions to acquire more capacity on existing DTT multiplexes.

7.125 We have therefore decided not to intervene in favour of DTT services in SD in the award of the digital dividend. However, we believe it is important to consider the issues faced by such services that generate broader social value. We will do so in our second PSB Review, which is currently under way.

7.126 Table 7 summarises our application of the total value framework to DTT services in SD. Annex 2 sets this out in more detail.

Table 7. Application of the total value framework to DTT services in SD

Market failure	Case for intervention	Conclusion
Capital market failures	There is a risk of market failure in relation to capital market barriers faced by the BBC and Channel 4 The best option for resolving these would be to relax these barriers if justified	This issue is a matter for the Government, the BBC and Channel 4
Broader social value	The evidence of incremental broader social value generated by this use is insufficient to warrant intervening given the high opportunity cost If intervening is required in the future, the first best option would be direct funding. This option would not be precluded by our market led approach	No intervention in DDR

HD

7.127 The DDR consultation document assessed the risk that any of a number of different potential market failures could prevent bidders fully reflecting their valuation of spectrum for DTT services in HD in a market led award. These were:

- capital market failures;
- the existence of broader social value generated by the availability of HD content in general;
- the risk that bidders will not reflect in their willingness to pay for spectrum the potential negative impact on the DTT platform of a failure to acquire spectrum to deliver DTT services in HD;
- the risk that bidders will not reflect in their willingness to pay for spectrum the importance of universally available PSB content in HD for generating broader social value;
- coordination problems; and
- the risk that services funded by advertising will under-represent the total value that they generate.

Consultation responses

7.128 As discussed at the beginning of this section, we received a very large number of responses on this issue. Many of the responses also related to our assessment of the risk of market failure for HD.

7.129 Many respondents saw a need to reserve spectrum for DTT services in HD to allow a critical mass of five channels to be delivered. PSBs and HDforAll argued that this would not be possible using existing capacity.

7.130 A number of respondents argued that the DTT platform would decline if additional spectrum were not made available for DTT services in HD and that spectrum be reserved for this use. In particular, they claimed that HD would be the new broadcasting standard and that the DTT platform would lose audience share to other delivery platforms.

7.131 PSBs claimed that they were not capable of acquiring spectrum at auction. They often cited MNOs as having access to greater funds and claimed that the incremental revenue from DTT services in HD, where applicable, would not be sufficient to fund bids. In return, the PSBs stated that they would be willing to accept various conditions (e.g. a requirement to provide near universal access) for the gift of this spectrum.

7.132 There were also a significant number of responses from individuals supporting HDforAll and gifting spectrum to PSBs for DTT services in HD. Those critical of our proposals in this area often raised questions about our market research (see below).

7.133 However, a number of respondents expressed strong support for our proposal to package the spectrum in a way that would be suitable but not reserved for DTT. This group felt that our arguments for a market led approach were strong and that there was no basis for departure in respect of DTT services in HD. To do so would distort competition, compound the significant intervention of gifting spectrum to the existing six DTT multiplexes and introduce significant opportunity costs (notably by increasing spectrum scarcity for other uses). This group included MNOs, BT, other telecommunications organisations and BSkyB.

Our response

7.134 In response to the request to gift further spectrum for DTT purposes, we note that almost 70% of the spectrum released at DSO has already been reserved for DTT. This will bring better coverage, better reception and more free to air channels. Our remit is to consider how best to release the remaining 30% of this spectrum for new uses.

7.135 In relation to the capital market failure risk, our assessment is the same as that for DTT services in SD. This is that the capital market failure is a potential risk, and we believe that this is a matter for the Government, the BBC and Channel 4. Table 7 above summarises the application of our framework to this issue.

7.136 At the time of the DDR consultation document, there was significant uncertainty about the strength of demand for DTT services in HD. This has lessened to some degree. It seems clearer now that HD will play an important role, with uncertainty instead about the mix of SD and HD content that consumers will demand.

7.137 The issue at the heart of the consultation responses is whether the DTT platform is able to deliver services in HD using its existing capacity and, if not, whether the importance of additional spectrum would be reflected in a market led award of the digital dividend. We have looked closely at this, particularly the options for PSBs to increase the capacity of the DTT platform, through both technological improvements and the acquisition of additional spectrum, to deliver new services.

7.138 As indicated in our recent DTT consultation document and the announcement by the PSBs supporting our proposals,[43] we believe it is credible to deliver PSB content in HD using existing capacity. This is because significant additional capacity—at least 20% more than now—will be created on the DTT platform by DSO. Use of this capacity in combination with technological upgrades provides the opportunity to deliver services in HD, if this is the best use of the capacity. In our consultation, we set out the reasons why we believe the platform would be able to organise itself to move to new technologies if there are benefits from doing so. The market failure risk we identified in the consultation was whether the pace and scale of this upgrade would be optimal. We welcome the announcement by the PSBs in advance of the digital dividend awards as we believe this will allow them and others interested in delivering services over the DTT platform to make a better assessment of their need for additional spectrum.

7.139 It is worth noting that our decision to consult on the options for upgrading the DTT platform to new technologies is independent of our work in the DDR. Although there are clear links, we believe upgrading the DTT platform to secure more efficient use of existing spectrum would be justified even if the digital dividend was not available. However, the platform's ability to evolve in the longer term is an important consideration, for both us and industry, when assessing how important additional (digital dividend) spectrum is to the platform. We have therefore taken the recent announcements into account in assessing whether there is a risk of market failure in relation to DTT services in HD that warrants intervening in the award of the digital dividend. This does not mean that when the platform is upgraded, the additional capacity should or will be used for HD. Rather, it means that the upgrade provides the opportunity for HD if the value of this use turns out to be such that it is the best use of this capacity.

[43] www.bbc.co.uk/pressoffice/pressreleases/stories/2007/11_november/20/hd.shtml.

7.140 Given the ability of the DTT platform to provide PSB content in HD using existing capacity, in the case where this is the best use of the capacity, we believe that intervention in the award of the digital dividend for this use is not justified. Moreover, we consider that the move to new technologies on the platform will promote a virtuous circle of consumer take-up of equipment that receives services broadcast using those technologies. This will, in time, allow other multiplexes to expand their capacity by moving to these new technologies and hence provide many options for expanding the range of services in HD (and SD) if consumer demand warrants this. If HD does become the standard mode of broadcast, there will be strong incentives for the platform to develop in this way.

7.141 We also note the findings of the House of Commons Select Committee on Culture, Media and Sport in its report on public service content in relation to this issue:

> We have continued to listen to the arguments but we fail to see how transmission of extra high definition digital terrestrial television channels delivers sufficient extra public value to justify intervention. In any case, we note that Ofcom and the public service broadcasters have agreed in principle that it is technically possible to transmit up to four channels in high definition within their current allocation of spectrum. We agree that the most appropriate use of the vacated spectrum is best determined by market mechanisms and note that this will still allow the broadcasters the option of purchasing additional spectrum in the market place.

7.142 We consider that the incremental broader social value that might be generated by using the digital dividend to provide additional capacity to the DTT platform for services in HD, above what might already be provided, is likely to be limited. Therefore, given the opportunity cost of intervening in favour of DTT services in HD (this is comparable to the opportunity cost of intervening for SD mentioned above) and the risk of regulatory failure, we have decided not to intervene to set aside spectrum for DTT services in HD. This does not mean that we think that DTT services in HD are not a plausible use of the digital dividend, just that we do not think it is appropriate to intervene to favour this use over others.

7.143 Table 8 summarises our application of the total value framework to DTT services in HD. Annex 2 sets this out in more detail.

Table 8. Application of the total value framework to DTT services in HD

Market failure	Case for intervention	Conclusion
Capital market failures	There is a risk of market failure in relation to capital market barriers faced by the BBC and Channel 4 The best option for resolving these would be to relax these barriers if justified	This issue is a matter for discussion between the Government, the BBC and Channel 4
Broader social value: general	The evidence of incremental broader social value generated by this use relative to others is insufficient to warrant intervening by allocating spectrum additional to the 256 MHz already reserved for DTT	No intervention in DDR

Market failure	Case for intervention	Conclusion
Broader social value: detrimental effects on the DTT platform	The evidence of detrimental effects on the DTT platform is uncertain If there are significant detrimental effects in the future, these could be remedied by using existing spectrum to offer HD services	No intervention in DDR
Broader social value: universal availability of PSB content in HD	A future requirement for universal availability of PSD HD content is possible but not certain There is sufficient capacity within the existing spectrum reserved for DTT to allow this to be provided without further spectrum being allocated	No intervention in DDR
Coordination failures	The coordination problem faced by bidders for spectrum for an additional DTT multiplex to offer HD services are not significant enough to suggest a market failure risk See annex 2 for detailed discussion	No intervention in DDR
Advertiser funding business model failure	The use of the advertiser funding business model by some bidders does not provide significant evidence of a market failure See annex 2 for detailed discussion	No intervention in DDR

Mobile broadband

7.144 Mobile broadband comprises future cellular and Internet access services such as future evolutions of 3G cellular mobile, Mobile WiMAX and the complete family of IMT technologies (previously known as IMT-2000 and IMT-Advanced). Annex 7 sets out recent developments related to these services. In summary, they are as follows:

- our 2007 market research has indicated that improved mobile phone and mobile broadband services generate high value for citizens and consumers;

- our technical analysis indicates that mobile services can, subject to appropriate constraints, operate in cleared spectrum without creating excessive interference to DTT. We are continuing to look at their operation in interleaved spectrum;

- our technical analysis has also indicated that using UHF bands IV and V would substantially reduce the cost of infrastructure to provide mobile broadband services to rural and built up areas compared to using higher frequency spectrum (e.g. 2100 MHz). However, more sites would be required than using 900 MHz spectrum in order to limit interference to neighbouring countries in accordance with GE-06; and

- economies of scale in the mobile equipment market may significantly affect the value to society that can be generated by use of the digital dividend for mobile services. Our work to help realise these is set out in section 3.

7.145 The DDR consultation document considered there to be one potential source of market failure that could prevent mobile broadband bidders from participating at auction on an equal footing. This is the risk that universal access to mobile broadband generates broader social value that is not reflected in bidders' willingness to pay for spectrum. We concluded that the risk of the presence of broader social value resulting in a market failure in the award of the digital dividend is limited and so proposed to take no action beyond packaging the spectrum in a way that does not preclude mobile broadband use.

Consultation responses

7.146 218 responses (172 from individuals and 46 from organisations) specifically addressed this issue. A number of others touched on it in the context of other points.

7.147 Approximately a third of individual respondents agreed that we should not preclude mobile broadband use of the digital dividend, while two thirds disagreed. Most of those who disagreed did so because they supported reserving spectrum for other uses (e.g. DTT services in HD and PMSE).

7.148 Most of the organisations that responded agreed with our proposals. Some, particularly telecommunications companies, also thought that we needed to achieve EU harmonisation of a sub-band of the digital dividend, thereby securing economies of scale.

7.149 The Scottish Executive (now the Scottish Government) and the Welsh Assembly Government both felt that there was a strong case for reserving spectrum for this use. Other groups argued that we should allocate some spectrum for a licence exempt mobile broadband service.

7.150 Annex 4 contains a detailed consideration of responses to this issue.

Our response

7.151 We are still of the view that the potential for market failure related to mobile broadband in a market led award of the digital dividend is too low to justify intervening in the award. The reasons for this are twofold:

- we believe that the high private value for using the digital dividend for mobile broadband is likely to be correlated with the high broader social value. This means that, while the broader social value will not be directly reflected in bids, those made are likely to be sufficiently reflective of the relative total value of this use when compared to others; and

- the key market failure risk in relation to mobile broadband seems to be a risk that individual operators' rollout decisions may fail to reflect the broader social value generated by universal access. While the degree of rollout is not independent of the spectrum available, mobile operators are unlikely to require the digital dividend to achieve universal access. If wider access is required in the future, the most effective intervention option to deliver this may be providing operators with direct funding targeted directly at the additional rollout desired. This would be more likely to create incentives for the most efficient delivery of the service than imposing controls on inputs, such as the digital dividend. This is similar to the approach that has been employed by Regional Development Agencies and others to achieve greater availability of fixed broadband services.

7.152 We also note that the opportunity cost of intervening in favour of mobile broadband uses is potentially very high. Our modelling work (as discussed in annexes 2 and 8) suggests that this could plausibly be in the region of £1-2.5bn (NPV over 20 years). This suggests that we would need very strong evidence of market failure before deciding to intervene in the award of the digital dividend.

7.153 We also do not accept the argument that we should exclude mobile broadband from the award:

- all the available evidence suggests that mobile broadband is as likely to generate high value for society as other potential uses of the digital dividend, including DTT services in HD. International developments (e.g. at WRC-07 and in the United States) are increasing the plausibility of mobile broadband as a use; and

- as discussed above, we do not accept the arguments for reserving spectrum for DTT services in HD, nor do we accept that intervening is required to restrict mobile broadband use in order to protect PMSE users. Our approach to ensuring that PMSE users have sufficient access to spectrum is discussed above.

7.154 We have therefore decided not to intervene in favour of mobile broadband in the award of the digital dividend. We will ensure that packaging and award design reflect our support for non-mandatory, non-exclusive European harmonisation of a sub-band that can provide economies of scale for equipment.

7.155 Table 9 summarises our application of the total value framework to mobile broadband. Annex 2 sets this out in more detail.

Table 9. Application of the total value framework to mobile broadband

Market failure	Case for intervention	Conclusion
Broader social value	It seems plausible that wider access to mobile broadband may generate broader social value. However, there is insufficient evidence of the need to intervene in the award of the digital dividend to achieve this If intervention is required in the future to achieve wider geographic access to mobile broadband services, the first best option may be direct funding. This option would not be precluded by our market led approach	No intervention in DDR

Mobile television

7.156 The DDR consultation document noted the suitability of UHF bands IV and V for providing mobile television. It noted the suitability of other spectrum, some of which, at L-Band (1452-1492 MHZ) and 2.6 GHz, we expect to auction in the first half of 2008. Additionally, mobile multimedia services are already being offered over 3G.

7.157 According to the results of our 2007 market research, consumer interest in mobile television appears to be lower than in other potential uses of the digital dividend, though a significant minority of consumers appear very interested. Additionally, mobile television is a nascent service, so current consumer appeal may not fully reflect the future level of demand, and stakeholders have expressed a high level of interest in using the digital dividend to provide mobile television. There is an interest in acquiring spectrum for this use among those with an established interest in mobile cellular and broadcasting (e.g. MNOs, mobile equipment manufacturers and broadcasters such as BSkyB).

7.158 Our economic modelling indicates that, allowing for a wide variety of assumptions about how services might develop over time and the availability of other spectrum, mobile television is a plausible use of the digital dividend with a potentially high value to society, particularly consumers.

7.159 We have also taken into account the Commission Communication on strengthening the internal market for mobile television, published on 18 July 2007.[44] This calls on Member States to facilitate the deployment of mobile television, including by making spectrum in UHF bands IV and V available as quickly as possible.

Consultation responses

7.160 A number of respondents stated that mobile television could be provided using other spectrum and so the digital dividend was not critical to its delivery. They nonetheless sought an overall view of spectrum suitable for use by mobile television that would be released by 2012.

7.161 MNOs and mobile equipment manufacturers stated their support for a harmonised sub-band for mobile television, claiming that this would deliver significant economic benefits and kick-start take-up in the UK.

7.162 Ericsson felt that demand for all mobile applications was growing. Nokia felt that the UK risked lagging behind the rest of Europe on mobile television and that the London Olympics were a major opportunity for mobile television. Nokia argued that mobile television’s contribution to the economy would be different if it used the digital dividend rather than L-Band. Nokia also argued that mobile television could use interleaved spectrum.

7.163 There was a distinct lack of support for mobile television from individuals who responded. Some raised potential safety concerns about using handheld equipment when driving. Others felt that this was a niche market and pointed to a lack of demand for or interest in services that are already available. RNID also felt that there was no technical need or consumer demand. However, ACOD noted the usefulness of mobile television in social care situations.

7.164 Digital TV Group was looking at deploying low power networks for mobile television and other services where collocation with DTT transmitters is not possible.

7.165 Qualcomm stated that its consumer research had shown high demand for mobile television and that it would need only small packages of spectrum—8 MHz—to deliver it.

7.166 Intellect noted that mobile television might be advertising based rather than pay per view. It thought that our analysis of mobile television fit the experience in Europe.

7.167 Arqiva noted current progress in Finland and Italy and the potential impact of the London Olympics on mobile television. It believed that there was proven demand for this service, pointing to the O_2/Arqiva DVB-H consumer trial as an indicator. It argued that other spectrum would be less efficient than UHF bands IV and V and highlighted that market led harmonisation was already under way throughout Europe for mobile television use of this spectrum.

Our response

7.168 We are still of the view that there are no material market failure risks related to mobile television in a market led award of the digital dividend.

[44] http://ec.europa.eu/information_society/policy/ecomm/doc/library/communications_reports/mobile_tv/409_en_original.pdf.

7.169 No points raised by respondents suggest that our market failures assessment is incorrect.

7.170 Responses suggest that there is considerable interest among stakeholders in this use and a belief that delivering mobile television using the digital dividend may generate higher value than using other spectrum. Our economic modelling work takes this assessment into account and also suggests that mobile television is a plausible high value use of the digital dividend.

7.171 We have therefore decided not to intervene in favour of mobile television in awarding the digital dividend. We will ensure that packaging and award design reflect our support for non-mandatory, non-exclusive European harmonisation of a sub-band that can provide economies of scale for equipment for this use.

7.172 Table 10 summarises our application of the total value framework to mobile television. Annex 2 sets this out in more detail.

Table 10. Application of the total value framework to mobile television

Market failure	Case for intervention	Conclusion
No market failure issues identified	N/A	No market failure concerns

Conclusion

7.173 Table 11 summarises the findings of our assessment of whether there is a case for departing from our market led approach to the award of the digital dividend.

Table 11. Summary of assessment of departing from a market led approach

Service	Assessment of key case for intervention	Conclusion
PMSE	There is a transitional risk of a coordination failure for users who require high quality access to spectrum. These are due in part to the significant barriers these users currently face to participating in a market led approach PMSE users who are content to accept lower quality access face further issues. These are best resolved by accessing spectrum on a licence exempt basis	<u>Interventionist approach</u> Given the transitional coordination failure that results from the barriers these users currently face to participating in a market led approach to spectrum access, we have concluded that we need to reserve spectrum for this use We should also consider whether more could be done to facilitate access for some users on a licence exempt basis
Local television	There is a risk of a coordination failure that would be best resolved through auction design and packaging There is likely to be broader social value generated by the delivery of local content, but the incremental value generated by delivery via the DTT platform is unclear and is unlikely to be sufficient to result in a market failure Given the nature of the content, alternative delivery platforms (e.g. the Internet) may be a more efficient approach to realising the value generated	<u>Market led approach</u> Using auction design and packaging to resolve the coordination failure is consistent with a market led approach to the award of the digital dividend Direct funding could be provided to support this service in a bid for spectrum if the incremental broader social value warrants it

Service	Assessment of key case for intervention	Conclusion
DTT services in SD	The presence of broader social value generated by additional SD channels of a community/citizen nature does not suggest that there is a market failure that should be rectified through reserving spectrum This is a wider issue that is likely to be better resolved through other means. This could involve acquiring additional capacity on existing multiplexes and/or delivery over other platforms (e.g. the use of PVRs or the Internet) that might be better suited to some of this content	Market led approach We will consider the wider issues raised by community/citizen channels in the second PSB Review Direct funding could be provided to support this service to acquire more multiplex capacity (and/or spectrum) if this is warranted
DTT services in HD	There is potential for broader social value to be generated by providing PSB content in the future in HD However, this does not constitute a market failure that requires us to intervene in awarding of the digital dividend. It is already expected to be possible to deliver DTT services in HD without extra spectrum. If the situation arises where HD is the universal broadcasting standard (and hence clearly the best use of DTT capacity), the platform will have very strong incentives to evolve in this direction	Market led approach
Mobile broadband	It is reasonably likely that widespread access to mobile broadband would generate broader social value. However, this is unlikely to result in a market failure in the award of the digital dividend given the strong private incentives potential operators have to acquire low frequency spectrum to provide wider coverage for mobile services at lower cost	Market led approach If the level of rollout achieved in the future is lower than required from the perspective of broader social value generated by universal access to this service, this can be resolved through targeted direct funding
Mobile television	There are no identified market failure issues for this service	Market led approach

Section 8

The digital dividend awards

Introduction and summary

8.1 This section sets out our decisions on implementing the digital dividend awards, in particular the mechanisms for releasing the spectrum. We conclude that where we do not reserve spectrum for a particular use, the appropriate mechanism for award is an auction.

8.2 In practice, this means that we will not intervene in the award of cleared spectrum. These will be auctioned on a service and technology neutral basis.

8.3 We will, however, intervene in the award of interleaved spectrum by reserving spectrum for use by a band manager who will have obligations toward PMSE users. We propose to award this spectrum via a beauty contest.

8.4 We will also package some interleaved spectrum to address the coordination failures faced by local television operators that we identified in section 7. This spectrum, and our proposed award of channels 61 and 62 where they are available, will be auctioned on a service and technology neutral basis.

8.5 This means we propose to hold three distinct awards of interleaved spectrum:

- a beauty contest for a package with PMSE obligations;
- an auction for geographic packages suitable but not reserved for local television in about 25 locations throughout the UK; and
- an auction for channels 61 and 62 where they are not being used for DTT.

8.6 We expect the award of channels 61 and 62 to be grouped in practice with the award of cleared spectrum.

8.7 We will consult on the detailed design of these awards.

Mechanism for award

8.8 The DDR consultation document set out our preference for auctions as the most efficient mechanism for awarding the digital dividend under a market led approach and hence the approach that would be expected, in the absence of market failures, to maximise the total value generated by using the digital dividend. This meets our general policy, set out in the SFR, that auctions are the most open, transparent and non-discriminatory method for awarding spectrum. Alternative mechanisms, such as beauty contests (also known as comparative selection), carry the risk of subjective judgements and not awarding spectrum to the user best able to maximise value to society. A well designed auction, with appropriate licence conditions and packaging, should give the market maximum flexibility to determine who uses spectrum, for what and how. This further reduces the risk of regulatory failure and unnecessary intervention inherent in other approaches.

Consultation responses

8.9 We received responses from all groups of stakeholders. Views were divided not just between different groups but also between respondents within the same group.

8.10 Broadly speaking, organisations such as the MNOs, BSkyB and BT were in favour of auctioning the digital dividend.

8.11 The PSBs did not support auctioning the entire digital dividend. Their reasons mainly centred on their ability to deliver their DTT services in HD and their view that more free to air services would bring enormous societal benefits to the UK. The PSBs felt that they would not be able to compete financially with large private organisations (notably the MNOs) in an auction and argued for an appropriate amount of the spectrum to be reserved to operate an additional DTT multiplex reserved for HD. The PSBs had strong support from a wide range of stakeholders, including the Digital Supply Group, Sony and individuals. A number of these argued that the DTT platform would fail if services were not provided in HD.

8.12 OSAB supported our proposals but sought assurance that packages would be suitable for a wide range of applications and confer no inherent disadvantage to UK competitiveness. ACNI also agreed with auctioning. OCP felt strongly that the award process should reflect the broader social value of services and urged us to do more work on this. It also proposed that some spectrum be held back in the form of a “spectrum bank” for future uses with high broader social value.

8.13 Other concerns raised by respondents stemmed from fears of spectrum hoarding and the perceived inability of some organisations, which pursue purely social goals, to take part in an auction.

Our response

8.14 We do not believe that there is sufficient evidence to justify awarding the digital dividend, with the exception of a package with PMSE obligations, by a mechanism other than auction. Our response to the cases for intervention (e.g. for DTT services in HD and local television) is detailed earlier in this statement. This explains why we do not believe it is necessary to depart from a market led approach for any use other than PMSE in order to maximise the total value generated by using of the digital dividend.

8.15 Packages suitable for local television could, as discussed below, facilitate national as well as local or near UK wide services. Interleaved spectrum not awarded at auction and not necessary for PMSE could also be made available by the band manager for other uses.

8.16 As discussed in section 5, markets are good mechanisms for deciding the optimum use of inputs in the economy, and direct funding is in general a better way of providing subsidies to services that deliver broader social value than gifting inputs like spectrum.

8.17 Our approach to auction design will seek to ensure that packages are suitable for as wide a range of services as possible taking into account likely levels of demand. We will pay careful attention to how award design can help to promote competition. Section 10 sets out our views on the importance of considering competition issues when designing the digital dividend awards.

Packaging

Cleared spectrum

8.18 The DDR consultation document proposed packaging cleared spectrum on a service and technology neutral basis suitable for any potential use.

8.19 It outlined six potential packaging options, from a single lot of 120 MHz to 15 lots each of 8 MHz. These are summarised in table 12. These options assumed UK wide coverage and sought to minimise the effects of interference, both domestic and international, and aggregation risk. They also took account of GE-06 assignments, set in 8 MHz channels, and the potential need for new international agreements.

Table 12. Potential packaging options for cleared spectrum

Lots	Channels
1	31-37 + 39-40 + 63-68
3	31-37 • 39-40 • 63-68
4	31-34 • 35-37 • 39-40 • 63-68
4	31-33 + 63-65 • 34-37 • 39-40 • 66-68
5	31-33 • 34-37 • 39-40 • 63-65 • 66-68
15	31 • 32 • 33 • 34 • 35 • 36 • 37 • 39 • 40 • 63 • 64 • 65 • 66 • 67 • 68

8.20 We sought comments on which of these options would be most suitable.

Consultation responses

8.21 Taken together, there was no common view among the 86 responses that we received. Many respondents were waiting until further information was supplied and matters of uncertainty (e.g. EU harmonisation) resolved.

8.22 More flexibility and packages that permitted optimal aggregation were favoured over a single lot as these provided for the widest range of services from the widest range of providers. Mobile television operators, telecommunications providers and PSBs (once sufficient spectrum for a DTT multiplex was reserved) favoured smaller lots, although they noted the complexity of this approach. Many respondents highlighted competition concerns that might result from a single lot.

8.23 Some respondents agreed that cleared spectrum should be packaged in a way suitable but not reserved for mobile broadband. Most organisations and individuals took this view, as did ACOD and ACS. Some, principally the Scottish Executive and the Welsh Assembly Government, argued that spectrum should be reserved for mobile broadband. Electrical retailers and some individuals argued that this use should be excluded because the spectrum should only be used for DTT services in HD. Some individuals also believed that the properties of the digital dividend made it better suited to services other than mobile broadband. OSAB thought that the markets for mobile broadband and mobile television might converge in due course, and ACNI wanted the possibility of all Ireland services to be considered.

8.24 The four and five lot options gained more support in general. However, many respondents thought that the options needed to take better account of the suitability of a single 8 MHz channel for mobile television use.

8.25 There were some concerns about whether UK wide packages were appropriate. For example, ACNI suggested that a separate approach might be needed for Northern Ireland given a potential lack of bidders and all Ireland spectrum issues.

8.26 Consumer bodies and community groups were concerned that our proposals were not suitable for local and community media and broadcasters.

Our response

8.27 We remain in favour of auctioning cleared spectrum on a UK wide basis, although we are discussing our proposals with the Irish authorities. We will do this in a way that allows the widest possible range of uses including DTT, mobile television and mobile broadband. This will permit maximum flexibility of use and therefore ensure that the market and ultimately users will decide the best use.

8.28 We have made no decisions about the detailed design of the packaging. We will consider this issue in greater detail when consulting on detailed award design.

Interleaved spectrum

8.29 The DDR consultation document proposed packaging interleaved spectrum as follows:

- a large number of packages consisting of a single (interleaved) channel that could be used to provide a broadcast-like service at moderate to high power from an individual main station transmitter. These packages would be suitable but not reserved for local television use as there are other potential uses. One or two packages could be made available in each of up to 50 main station areas. This would imply a total of between 50 and 100 such packages. Use would not be limited to such high power broadcast transmissions, but the usage rights would be compatible with this use; and

- a small number (perhaps one, two or three) of larger packages consisting of the right to use a subset of interleaved spectrum across the whole of the UK while having to protect other services. These packages would be suitable but not reserved for PMSE use, subject to transitional protection for PMSE users to ensure that they could continue to access interleaved spectrum until at least the end of 2012.

8.30 Again, we sought comments on which of these options would be most suitable.

Consultation responses

Packaging suitable for local television

8.31 The PSBs were generally supportive of our proposals for these packages and did not favour any further action in support of local television.

8.32 Within the local television sector, there were broadly two groups of respondent:

- one group felt that interleaved spectrum was insufficient to provide a reasonable level of service since it would not allow UK wide and/or universal service. Instead, the only viable option was the add/drop solution on the DTT platform; and

- another group felt that interleaved spectrum was the best route for providing services but was concerned about how local television operators could secure access. It preferred gifted spectrum to auctions and was not convinced that broader social value could be secured under a market led approach.

8.33 A number of respondents thought that measures might be required to ensure that these packages were used for local television rather than a sub-UK DTT multiplex and to prevent PSBs from bidding. Other respondents proposed changes to the award process to give local television better prospects of acquiring the packages.

Packaging suitable for PMSE

8.34 Responses to our proposals were set out in our PMSE consultation document.

8.35 That consultation document favoured awarding a single package of interleaved spectrum with obligations relating to PMSE use. This reflected users' negative experiences of dealing with more than one service provider prior to 1996 and our own view that dividing the spectrum into separate packages was unlikely to have significant competition benefits, at least in the short term. This was because of restrictions on the tuning range of equipment and/or users' need to access large quantities of spectrum for special events.

8.36 Respondents to the PMSE consultation document again expressed a strong preference for a one stop shop for spectrum use and hence for a single package of interleaved spectrum to be assigned to a band manager. They understood that this would result in a dominant supplier of spectrum for many PMSE applications but hoped to receive protection by virtue of price controls placed on the band manager.

Our response

8.37 Respondents identified a number of potential uses of interleaved spectrum, including:

- local television;
- one sub-UK DTT multiplex;
- PMSE; and
- mobile communications services like voice and data.

8.38 Each of these could make use of cleared and/or interleaved spectrum, although services such as local television and PMSE are better suited to interleaved spectrum.

8.39 Our high level approach to identifying packages of interleaved spectrum has been to assess where there is strong evidence of demand from non-PMSE uses and, where this is the case, to pursue a market led award. We think that remaining interleaved spectrum, for which the current evidence of demand from alternative uses is less strong, should be assigned to the band manager with PMSE obligations. We intend to ensure that the band manager has incentives to promote spectrum efficiency and hence will be able to allow other (non-PMSE) users to access its spectrum so long as reasonable PMSE demand has been met.

8.40 We think this approach to identifying packages of interleaved spectrum appropriately balances the need to provide sufficient spectrum for PMSE users with promoting spectrum efficiency. Hence, this approach is consistent with our objective for the DDR of maximising the total value generated by using the digital dividend.

8.41 Using this approach, we have decided:

- to award one or two packages suitable but not reserved for local television in about 25 locations with known or likely demand for this use;
- to propose awarding a package of channels 61 and 62, where not already assigned, suitable but not reserved for two way mobile use. This reflects TG4's preferred sub-band of channels 62 to 69 and the close proximity of channels 61 and 62 to cleared spectrum in the UK; and
- a single package comprising most interleaved spectrum and with obligations relating to PMSE use, to be awarded by beauty contest to a band manager. This will avoid the risk of market failure faced by PMSE users.

8.42 The evidence we used when identifying sources of demand is set out below. In this discussion, we also reflect on the issues raised by respondents.

Packaging suitable for local television and DTT

8.43 These packages will comprise one or two in group channels able to permit broadcasts at sufficient power to be received by most households in the transmitter coverage area. NGW investigated the availability of frequency assignments within interleaved spectrum that would be suitable for local television and DTT at 71 main transmitter sites (see NGW technical report). We anticipate awarding packages in about 25 locations.

8.44 This is less than the 50 locations mentioned in the DDR consultation document but, we believe, reflects reasonable demand for local television. It takes into account the level of population coverage that may be required for this service to be commercially viable as well as areas where local television is already available. We would consider adding further locations identified by potential providers, including community operators, as being of interest. We will consult on the locations in the next phase of the DDR. We intend to invite views on whether to add more sites to, or indeed subtract sites from, this list by inviting those parties interested in providing local television services to provide evidence of demand.

8.45 Table 13 gives an indicative list of these 25 locations. The number of households that it reports as served is likely to overstate the actual coverage that could be achieved as it assumes transmission from the top of the transmitter tower and does not take account of potential interference from other services.

Table 13. Indicative list of packages suitable for local television and DTT

Channel	Main city/county/ surrounding area	Active RSLs	Transmitter	QPSK—max. households served (millions)	64QAM—max. households served (millions)
29	Greater London		Crystal Palace	3.9	2.9
56	Manchester/Liverpool/ surrounding region	Channel M	Winter Hill	3.0	2.6
51	Glasgow/part of Edinburgh		Black Hill	1.4	1.2

Channel	Main city/county/ surrounding area	Active RSLs	Transmitter	QPSK—max. households served (millions)	64QAM—max. households served (millions)
51	Birmingham/West Midlands		Sutton Coldfield	1.3	0.9
56	Newcastle		Pontop Pike	1.2	1.0
45	Yorkshire (Leeds, Doncaster, York)		Emley Moor	1.0	0.7
24	Middlesbrough/York/North Yorkshire	York	Bilsdale	1.0	0.6
29	Southampton/surrounding region		Rowridge	0.8	0.5
55	Leicester	MATV	Waltham	0.8	0.4
52	Part of Edinburgh		Craigkelly	0.7	0.6
51	Cardiff	Capital TV	Wenvoe	0.7	0.5
21	Lincoln/Kingston or Hull		Belmont	0.7	0.3
43	Reading/Newbury		Hannington	0.5	0.2
30	Belfast	NvTv	Divis	0.4	0.3
57	Norwich		Tacolneston	0.4	0.3
49	Cambridge/Northampton/ Peterborough		Sandy Heath	0.4	0.2
55	Bristol		Mendip	0.3	0.2
49	Ipswich/Suffolk		Sudbury	0.3	0.2
49	Oxford	Six TV	Oxford	0.3	0.2
48	Wolverhampton/Telford		The Wrekin	0.3	0.2
57	East Kent		Dover	0.3	0.1
54	Sussex		Heathfield	0.2	0.1
21	Carlisle	Carlisle TV	Caldbeck	0.1	0.1
30	Herefordshire		Ridge Hill	0.1	0.1
48	Londonderry	Channel 9	L/derry	<0.1	<0.1

8.46 As discussed in section 7, we have given further consideration to the option of delivering local television via add/drop. Although we recognise that this is a technically feasible option on either an existing or additional national multiplex, the proposal suffers from a number of fundamental disadvantages that mean that we do not support its implementation. These were set out in section 7.

8.47 Packages will be awarded by auction to the highest bidder, even where there is only one in group channel available. It is, of course, possible that potential local television operators may be outbid by a prospective multiplex operator or other users. However, it is important to note that a single multiplex can carry several video streams, so opportunities for local television may still exist if this happens. Section 7 and annex 2 consider whether there are any market failures that could justify reserving spectrum for local television or preventing other users from bidding for these packages. This assessment has concluded that there are no market failure risks that justify this form of intervention.

8.48 Ideally, we would conduct these awards at least a year before DSO to give successful bidders time to roll out their operations before spectrum becomes available for use. This is not possible for regions where DSO starts in 2008. This could cause significant problems for existing RSL operators in regions where DSO is relatively early as they cannot transmit in analogue after DSO in their region but might be unable to acquire an assignment enabling digital transmission sufficiently in advance of DSO. There are three such operators:

- the Carlisle RSL operator, located in Border, where the Caldbeck transmitter will undergo DSO in summer 2009;
- Channel M, located in Granada, where the Winter Hill transmitter and its dependent relays will undergo DSO in winter 2009; and
- the Cardiff RSL operator, located in Wales, where the Wenvoe transmitter will undergo DSO for March 2010.

8.49 We plan to award to award these packages sequentially, with the first set of packages in those locations (including the Caldbeck, Winter Hill and Wenvoe transmitters) in late 2008 and the remaining packages at a later date. We believe this is necessary to provide existing RSL operators with sufficient clarity prior to DSO about their options for future spectrum access. However, this approach does have some downsides as it may create aggregation risks for an operator who wishes to offer services in more than one area. We will take this into consideration when deciding whether to award the remaining packages sequentially or simultaneously.

8.50 We acknowledge that varying RSLs to permit digital transmission could help stem the loss of viewers due to increased digital take-up. It could also help local television operators to develop a business case for securing spectrum by allowing them to use their existing licences to test and develop digital transmissions. We will, subject to technical and legal feasibility and international coordination, consider requests to vary existing RSLs to permit digital transmissions until DSO or, in exceptional circumstances, the award of the digital dividend. Short duration or event RSLs for digital transmission will also be available on request, subject to spectrum being available. All technical, planning, capital and operational costs will need to be met by the licensee. For the avoidance of doubt, access to the spectrum for digital transmissions would be purely on a temporary basis and would not create a legitimate expectation of continued use following DSO or, where relevant, the award of the digital dividend.

Packaging suitable for two way mobile

8.51 As set out in section 3, TG4 has identified a preferred sub-band of UHF bands IV and V that could be made available across Europe on a non-mandatory, non-exclusive basis for two way mobile applications. TG4 has concluded that this sub-band should include, as a minimum, channels 62-69 (798-862 MHz). This aligns closely with part of the UK’s cleared spectrum, although channel 62 is only available on an interleaved basis and channel 69 is used for PMSE.

8.52 TG4 is currently looking at band plan options, some of which include extending the bottom edge of this sub-band down to channel 58. At the same time, we are investigating the feasibility of two way mobile use of interleaved spectrum. Initial indications are that downlinks are more likely to be feasible in interleaved channels than uplinks. This suggests that frequency division duplexing systems would potentially use interleaved spectrum for downlinks, with uplinks at the top end of the upper cleared spectrum, subject to appropriate technical constraints.

8.53 To maximise the potential benefits of harmonised spectrum use within Europe, we propose awarding interleaved channels 61 and 62 on a UK wide basis where they are available at the same time as cleared spectrum (including channels 63-68). We will consult on this proposal in more detail in the next phase of the DDR.

Packaging suitable for PMSE

8.54 In developing our proposals in relation to packaging suitable for PMSE, we have given careful consideration to our objectives for this sector, namely the need to:

- avoid disruption to PMSE users that adversely affects their ability to provide a wide range of services to citizens, consumers and business customers;
- facilitate the participation of PMSE users in a market led approach to spectrum, particularly to provide them with incentives for efficient use;
- promote the optimal use of the spectrum in relation to all potential uses and users over time; and
- avoid the risks of regulatory and market failure.

8.55 As discussed in section 7 and annex 3, we think these objectives have important implications for the approach we take to awarding this package and the obligations we impose on the band manager.

8.56 It is after taking into account the need to balance our objectives that we have decided to award a single package of remaining interleaved spectrum on the following basis (see annex 3 for the analysis completed to support these decisions):

- we will award the remaining interleaved spectrum by beauty contest to a band manager. We will seek to ensure through the beauty contest that its interests are aligned with those of the PMSE sector;
- the band manager will pay AIP as one essential part of developing a market led approach to spectrum access for PMSE users. The band manager will be able to make spectrum available for other uses but only where it is not needed to satisfy the reasonable needs of the PMSE sector;
- the band manager will need to make spectrum available to PMSE users on fair, reasonable and non-discriminatory terms. Annex 3 sets out further details of our initial thoughts on how we might interpret this requirement;
- the requirements to meet reasonable demand on reasonable terms will last until 2018. We believe that the mechanism for awarding the package (see below) greatly diminishes the risk that this date will represent a cliff edge at which PMSE users could lose all their access to interleaved spectrum. We also continue to believe that a decade of protection balances the lifecycle of equipment with the opportunity cost of precluding alternatives uses of the spectrum, giving the sector sufficient time to prepare for any change that even a PMSE friendly licensee felt compelled to introduce; and
- the licence will have indefinite duration. We will be able to vary or revoke it after a minimum term for spectrum management reasons. This will enable us to take further steps to protect PMSE users if justified.

8.57 Our further work on award design will consider in detail how each of the requirements above will be achieved. Implementing our proposals will necessarily involve answering a number of questions about how the desired level of protection for PMSE users can best be achieved in practice.

8.58 In the light of consultation responses, we have decided not to set aside any of channel 69 for licence exempt use. Instead, we will award this for licensed use to the band manager. We will, however, encourage and consider what more can be done to promote greater licence exempt use of channel 70 by PMSE users who do not need the quality of service afforded by licensed use.

8.59 We have made no decisions yet about including spectrum outside the digital dividend and currently used for PMSE in the package for award. This is because there are complex issues relating to spectrum usage rights that will require further careful consideration and discussion. We will consider this in detail when consulting on detailed award design.

8.60 Separately, we will shortly publish detailed information on interleaved spectrum that is likely to be awarded as part of this package and therefore available for PMSE use in each region after DSO takes place. We have already published our decision to allow temporary PMSE use of channels 63 to 68 in the regions where DSO will take place before the end of 2009, up to the point where new users need access to the spectrum.[45]

Conclusions

8.61 We conclude that where there is not a case for reserving spectrum for a particular use, the appropriate mechanism for awarding the digital dividend is by auction.

8.62 In practice, this means that:

- cleared spectrum will be awarded by auction. We will do this in a way that allows the widest possible range of uses;
- we will intervene in the award of interleaved spectrum by awarding a package of spectrum to a band manager with obligations to make this available for PMSE. We will award this by beauty contest;
- we will auction geographic packages suitable but not reserved for local television in a number of locations; and
- we propose to auction interleaved channels 61 and 62 on a service and technology neutral basis.

8.63 We will consult on detailed award design in the next phase of the DDR.

[45] www.ofcom.org.uk/consult/condocs/pmse/statement/statement.pdf.

Section 9

Award timing

Introduction and summary

9.1 This section sets out our position on the timing of the digital dividend awards. We maintain our preference for awarding the digital dividend as soon as possible so that citizens and consumers can benefit from new services as soon as possible.

9.2 We plan to auction geographic packages of interleaved spectrum suitable but not reserved for local television sequentially, starting with packages in the Border, Granada, West Country and Wales regions before the end of 2008. We plan to auction the remaining geographic packages in 2009.

9.3 We plan to award the package of interleaved spectrum with PMSE obligations by beauty contest also before the end of 2008.

9.4 We will auction channel 36 alongside cleared spectrum because it is both a complement to and a substitute for that spectrum and an earlier award could result in a less efficient use of the digital dividend as a whole. As a consequence, we expect to auction cleared spectrum, channel 36 and (if confirmed) interleaved channels 61 and 62 during summer 2009.

Consultation proposals

9.5 We generally prefer to award spectrum as soon as possible because this allows citizens and consumers to receive new services with minimum delay. The DDR consultation document proposed that we do so in this instance. We expected to hold the award at least 16 months after consulting on detailed award design, suggesting late 2008.

9.6 The consultation document proposed awarding channel 36 alongside cleared spectrum, assuming that clarity and certainty about rights of use could be achieved in time. We favoured this approach for two reasons:

- the most efficient use of channel 36 might be in combination with other parts of the digital dividend. Early award of the channel could require participants to bid without certainty that they would acquire other spectrum subsequently. Bidders might consider this risk too great, with the consequence that some uses of value to society might not be realised. This would be an inefficient outcome; and

- a standalone award of channel 36 could only be held a matter of months earlier than the award of cleared spectrum anyway due to the legal steps necessary to hold an award.

9.7 The consultation document sought views on our proposals for timing and invited alternative suggestions with supporting evidence and analysis.

Cleared and interleaved spectrum

Consultation responses

9.8 This was a key issue. Some respondents argued for the award to be brought forward, while others suggested delay. Early award of channel 36 to enable the provision of mobile television was a factor for many who supported an earlier timeframe. This is discussed in more detail later in this section.

9.9 There was broad support, principally from telecommunications organisations, network providers, our advisory committees and mobile television providers, for our proposals. Some respondents noted the need for certainty in both the UK and the EU. Respondents, such as Microsoft and Philips, who favoured cognitive access noted that such licence exemption could be brought forward provided there was no harmful interference.

9.10 Most opposition to our proposals came from PMSE users, who sought additional protection for their spectrum use. They suggested that delaying a decision on channels 63-69 was necessary until more was known about the impact of losing access to the remaining cleared spectrum. The majority of broadcasters, some telecommunications organisations and some consumer bodies also considered that some delay was needed, mainly to take account of EU proposals for the digital dividend, to ensure harmonisation of spectrum bands and to allow sufficient time for analysis and planning by both us and stakeholders.

9.11 The high cost of bidding for cleared spectrum at auction in advance of its UK wide availability was also a concern, particularly for smaller organisations and those dependent on public funding. These respondents thought that more time was needed to allow them to secure necessary funding.

9.12 The PSBs requested that spectrum be held back until the demand for DTT services in HD could be properly assessed. A large number of individuals supported this view.

9.13 A few respondents noted the links between the timing of the award and the timing of DSO. It was thought premature for the former to take place before the first region, Border, completed DSO in 2009. Several respondents, including some MNOs, raised the need for potential sanctions and/or compensation if existing users did not vacate spectrum according to timetable (e.g. if DSO was delayed).

9.14 Specific to the interleaved spectrum, some respondents saw value in delaying award until primary users had certainty over their spectrum requirements, providing additional protection for DTT during DSO. It was suggested that this would reduce the likelihood of exaggerated bids.

9.15 Finally, some respondents favoured sequential release of some spectrum. They thought that this could assist new entrants and therefore foster competition. It was further noted that regional awards following the DSO timetable would benefit consumers by enabling use of spectrum as soon as it became available. Counter to this view, the higher risks associated with sequential bidding were raised.

Our response

9.16 We can award a licence to use spectrum in advance of its becoming available for use. We would simply make clear in the licence that rights of use did not start until some specified future date. The timing of the digital dividend awards is therefore separate from the timing of the spectrum's availability for use.

9.17 Those not in favour of early award noted the uncertainties associated with each of the potential uses of the digital dividend (e.g. because of possible EU harmonisation or uncertain future demand for DTT services in HD). We maintain that it is likely some uncertainty will be associated with some uses at any point in time and that postponing the award would not resolve this problem.

9.18 We also believe that delaying the award to confirm whether demand exists for a particular use would skew the process in favour of that use. This would be inconsistent with our service neutral approach.

9.19 We consider that our approach to PMSE and DTT services in HD, set out earlier in this statement, deal satisfactorily with the concerns about these uses raised by respondents. We also consider that our decisions on whether to intervene in the award of the digital dividend take appropriate account of the need for some participants to secure direct funding. As indicated in section 7, we will also give further consideration to how auction design can help bodies reliant on direct funding to take part in digital dividend auctions.

9.20 A staggered award would have some advantages, but it would also introduce risks for participants who need a combination of packages to deliver their services. They would be in the risky position of having to bid for spectrum that they might not be able to use if they were unable to acquire its complement at a later award.

9.21 We believe that arguments supporting delay are outweighed by the arguments to proceed with the digital dividend awards as soon as possible.

9.22 The motivation for early award is particularly compelling in regions with existing RSL operators who are seeking early certainty about continuity of service. Three such licensees are of particular concern:

- the Carlisle RSL in Border;
- Channel M in Granada region; and
- the Cardiff RSL in Wales.

9.23 We plan to auction geographic packages suitable but not reserved for local television in these regions and West Country before the end of 2008. This will give existing RSL operators early certainty about spectrum access after DSO. We recognise that this approach may create aggregation risks for operators who wish to offer services in more than one area. We will take this into consideration in awarding the remaining geographic packages.

9.24 We have also stated that, subject to technical and legal feasibility, we will consider requests to vary existing RSLs to permit digital transmissions until DSO or, in exceptional circumstances, the award of the digital dividend.

Channel 36

Clearance

9.25 Channel 36 is used in the UK for aeronautical radar. Clearing this use and renegotiating the international agreements that protect it are key barriers to releasing the spectrum for new uses. If these can be overcome, channel 36 could be cleared across the UK before DSO ends in 2012, ahead of the rest of the digital dividend.

9.26 Only one radar system, operated by BAE Systems, still uses channel 36. We have given notice that we will revoke its licence to use the channel by 31 March 2009.

9.27 At the same time, we are continuing to seek international agreement to use channel 36 for other services. We hope to achieve a degree of certainty with neighbouring countries in the near future and will then look to conclude bilateral agreements.

9.28 Taken together, these measures mean that new use of channel 36 in the UK could be possible during the course of 2009.

Consultation responses

9.29 23 respondents commented specifically on the timing of the award of channel 36. The majority argued for the channel to be awarded earlier than cleared spectrum.

9.30 In general, broadcasters, telecommunications organisations, network providers (including Arqiva) and mobile television operators supported early award, mainly to increase certainty about its use and boost mobile television in the UK. Many respondents saw the London Olympics as a key driver for mobile television and the early award of channel 36 as a key precursor. MNOs generally advocated early award, although some later stated a preference for the channel to be awarded alongside cleared spectrum.

9.31 Five opposed early award because of concerns about potential interference to its analogue television service in adjacent channels 35 and 37 from high power mobile multimedia services. Five argued that the award should be delayed if adequate safeguards were not in place.

9.32 BT was among the respondents who supported awarding channel 36 with cleared spectrum on the grounds of efficiency of process (so that resources would not be diverted from other awards), the flexibility it would provide to participants and the opportunity for different operators to launch services at the same time. Digital UK also felt that it was sensible to coordinate all the digital dividend awards, including that of channel 36.

9.33 A small number of stakeholders raised the prospect of delaying the award in light of any EU harmonisation measures if this would benefit the UK.

Our response

9.34 It is important to distinguish between early use of channel 36 (i.e. as soon as it is available and authorised for new use, before DSO finishes in 2012) and early award of the spectrum (i.e. before the award of cleared spectrum).

Early use

9.35 We agree that early use of channel 36 would enable earlier investment in network rollout, planning and testing and that services might therefore be provided earlier than would otherwise be the case. We also agree that early use brings with it some potential costs, notably in the shape of the interference concerns raised by Five. We have completed modelling work to estimate the magnitude of these benefits. This is discussed in annex 8 and suggests that three years' earlier use of channel 36 than would otherwise be possible could have benefits in the region of £200-500m (NPV over 20 years).

9.36 We also agree that early use brings with it some consequences, notably in the shape of the interference concerns raised by Five. To assess the impact of this, we engaged Aegis and ERA to quantify the possible effect that a densely deployed mobile television network (DVB-H was selected to model this) operating in channel 36 could have on Five's analogue television service operating in channels 35 and 37. We chose mobile television as it is one of the more likely uses of channel 36. While the results are not directly applicable to alternative technologies that can use channel 36, we believe that they provide a reasonable illustration of the potential magnitude of the problem, possibly in a worst case. For example, if channel 36 were used for an additional DTT (SFN) multiplex, we would expect the mitigation strategies available for preventing interference into Five's analogue service to be more effective.

9.37 The results suggest that approximately 3% of Five viewers who receive analogue television in these channels could suffer from interference ranging from almost imperceptible to a compete loss of picture, depending on their location relative to a mobile television transmitter. Mitigation techniques could reduce these effects, though not completely. The date at which a mobile television network using channel 36 came into operation is another mitigating factor because, as we approach the end of DSO in 2012, the number of remaining analogue only households will fall considerably. We understand from respondents that it would take two to three years for a phased rollout of a national mobile television network, so full rollout would not be achieved until 2011 or 2012 if channel 36 becomes available in 2009.

9.38 We have therefore decided to allow use of channel 36 as soon as it is available and authorised for new services, before DSO ends in 2012, on the condition that any use of this channel prior to 2012 does not materially degrade the reception of Five's analogue television service in this period. We believe that this approach will maximise the total value generated by using channel 36.

Early award

9.39 An early award of channel 36 would mean an auction ahead of cleared spectrum. Service providers could use the extra months to prepare their offerings, generating some benefits. We estimate these at up to £50m (NPV over 20 years) for a mobile television operator. (Annex 8 sets out our economic modelling work to support this figure.) However, these benefits are modest and less certain than the benefits of allowing early use.

9.40 Early award also involves potential costs. These are also uncertain, but the opportunity cost could be displacing certain uses that require more than one channel. These costs could be very high and adversely affect the efficiency of the award of cleared spectrum as a whole. Therefore, the costs are quite plausibly high compared to the potential benefits. Additionally, given the level of uncertainty, a decision to allow early award of channel 36 could be subject to a high risk of regulatory failure.

9.41 We consider the potential benefits of early auction to be too small to justify the risks that this would entail. Hence, we think that the total value generated by using the digital dividend would be higher if channel 36 is awarded at the same time as cleared spectrum.

9.42 There is one caveat to this decision. If the award of cleared spectrum is significantly delayed, the benefits of early award of channel 36 are likely to increase. In these circumstances, we would reconsider this issue.

Conclusion

9.43 In this section, we concluded that:

- we will auction cleared spectrum and channel 36 at the same time. Our current timetable indicates that this is likely to be in the first half of 2009. We will also propose to auction interleaved channels 61 and 62 at the same time;

- the early use of channel 36 will be subject to the new licensee not materially degrading Five’s analogue television service operating in adjacent channels;

- we plan to auction geographic packages of interleaved spectrum suitable but not reserved for local television sequentially, beginning in the Border, Granada, West Country and Wales regions before the end of 2008. This is intended to give existing RSLs certainty about their spectrum access after DSO. We plan to auction the remaining packages in 2009; and

- we plan to award the package of interleaved spectrum with PMSE obligations to a band manager by the end of 2008.

Section 10

Other issues

Introduction and summary

10.1 This section considers other issues on which we will consult further. It sets out the consultation responses we received in relation to:

- technical constraints;
- usage rights and obligations, particularly relating to competition; and
- auction design.

10.2 It also considers three final issues for the DDR:

- the London Olympics;
- multiplex licensing; and
- the Crown Dependencies.

10.3 We will address all of these issues in greater detail when consulting on detailed award design.

Technical constraints

10.4 The DDR consultation document proposed applying only essential constraints on future use of the digital dividend. These were requirements to meet international obligations and to protect uses of UHF bands IV and V that were already planned (e.g. DTT and radioastronomy) from interference. Annex 9 to the consultation document set out these constraints in detail. We sought comments on our analysis.

Consultation responses

10.5 We received 189 responses (133 from individuals) on our analysis of essential constraints and 138 (93 from individuals) on our detailed analysis and proposals regarding technical constraints. These broadly welcomed our recognition of the need to protect existing uses. However, many respondents argued for further detailed assessment of the scope for interference between uses.

10.6 MNOs and mobile equipment manufacturers argued that the risk of interference to DTT from two way mobile services was manageable. They stressed the benefits of identifying a harmonised European sub-band for such services. Some sought the relaxation of protection for radioastronomy in channel 38.

10.7 Broadcasting and PMSE respondents sought greater assurance on protection from interference, particularly the effects of hole punching (where high signal strength causes interference to the reception of a service operating in adjacent spectrum). Both groups doubted the feasibility of sharing frequencies with mobile equipment. Some broadcasters were pleased to see prioritisation given to PSB DTT multiplexes, while professional PMSE users argued for their use of channels 38 and 69 to be protected from adjacent high power users.

10.8 Several respondents noted the importance of prioritising DSO over the DDR given that the latter is dependent on the success of the former. The period between the digital dividend awards and the completion of DSO was a particular concern. A range of respondents commented on the uncertainty surrounding the effects of interference on the vast number of differing set top boxes in the market. It was thought that some assistance would be needed to reduce the possible impact on consumers.

10.9 Local television operators were unclear about the implications of the proposed constraints for their services. They noted the need for international coordination. ACW and the Welsh Assembly Government stated that they would be disappointed if no assignments suitable for local television could be made available at two of the main transmitters in Wales.

10.10 Areas identified by respondents as needing further investigation were:

- allowing licence exempt cognitive use of the digital dividend;
- protecting broadcasters' rebroadcasting signals;
- second, third and adjacent channel interference; and
- the use of SFNs as a way to improve DTT efficiency.

Our response

10.11 We have commissioned a suite of technical assessments to consider technical constraints more thoroughly. The results will inform our consultations on detailed award design.

10.12 This work has included further investigation into the compatibility issues between the different types of potential services that might use cleared spectrum. This highlights that the operation of a new service in cleared spectrum can cause interference to other new services (possibly using different technologies or network designs) operating in neighbouring channels. However, the technical research shows that this can be mitigated with careful network design and frequency separation.

10.13 The research also suggests that further improvements in the compatibility between different types of use could be gained by the adoption of better transmission and receiver filter performance compared to what was assumed in the earlier technical reports published with the consultation. The use of these improved filters could also improve the efficient use of cleared spectrum and simplify network deployment.

10.14 Section 7 summarised the different technical reports commissioned and their aim. Annex 9 contains links to more detailed summaries and the full reports.

10.15 Section 6 considered options for allowing cognitive use of the digital dividend.

Usage rights and obligations

10.16 The DDR consultation document proposed a number of non-technical usage rights and obligations. These were:

- licence terms—indefinite with a minimum term of 18 years (subject to five years' notice of variation or revocation);

- trading—all legal forms to be permitted;
- non-technical usage restrictions—only those necessary to protect against harmful interference, in line with a service and technology neutral approach; and
- service obligations—neither rollout obligations nor use it or lose it conditions, but some relating to PMSE use of interleaved spectrum.

Consultation responses

10.17 Of the 112 responses that we received, a small majority favoured additional restrictions to ensure efficient spectrum use and promote diverse, non-discriminatory and inclusive use, particularly on a geographic basis to prevent an increase in the digital divide and for the services offered.

10.18 Most broadcasters thought that a minimum licence term of 12-18 years was needed, although other respondents felt that this was too long and that shorter terms were more appropriate to take account of new technologies and to maximise spectrum efficiency. Broadcasters wanted licence terms aligned with those for the six existing DTT multiplexes.

10.19 Some community and consumer groups and individuals wanted provisions requiring demonstration of broader social value, to be transferred on any subsequent trade. Most respondents, particularly broadcasters and telecommunications operators, were keen that we formalise any arrangements to reduce interference risks.

10.20 The principal concern for many respondents was safeguarding against spectrum hoarding, particularly in light of indefinite licence terms, through use it or lose it conditions. Reasons for this were spectrum inefficiency and the potential impact on innovation and competition. Respondents proposed maintaining a revocation right on public policy grounds, even during the minimum licence term, for this reason.

10.21 Many respondents also suggested spectrum ownership caps to promote plurality of ownership and protect against anticompetitive practices, particularly in relation to single ownership of interleaved spectrum.

Our response

10.22 We will address issues of licence terms, trading and non-technical usage restrictions in preparing our consultations on detailed award design.

10.23 We have carefully considered the best way of ensuring that use of the digital dividend can generate broader social value. This was discussed in sections 5 and 7. In summary, we believe that a market led approach, supplemented by direct funding (where required) to reflect uses of value to society, is best suited to delivering this source of value and to maximising the total value generated by use of the digital dividend.

10.24 Competition issues both in the digital dividend awards themselves (e.g. the rules for participation) and in downstream markets that might be affected by the outcome of the awards are a critical consideration for the next phase of the DDR. Promoting efficiency, competition and innovation in spectrum use requires us to pay particular attention to the role that award design and packaging can play.

10.25 A range of mechanisms is available to us to resolve potential concerns, both as part of and after the awards. These include:

- award design and packaging that levels the playing field between incumbents and new entrants (e.g. capping the amount of spectrum an individual bidder can acquire);

- award design that minimises the risk of strategic behaviour by bidders;

- licence conditions that promote efficient use and competition. The DDR consultation document noted that we do not intend to impose any use it or lose it conditions because they are generally unlikely to be justified as a means of securing the optimal use of spectrum. We will nonetheless consider whether any other licence conditions are justified in this case (e.g. to prevent anticompetitive behaviour and/or promote competition); and

- using our powers as a competition authority to investigate anticompetitive behaviour.

10.26 We have not formed a view on the need to apply any such mechanisms to the digital dividend awards. We would only intervene where we believe there is a risk of market failure that would be resolved effectively through intervening.

Auction design

10.27 The DDR consultation document noted the links between packaging and the design of any potential auction, particularly in responding to aggregation risk. It also considered possible choices in auction design, including:

- simultaneous or sequential award of lots;

- a single round (sealed bid) or multiple rounds (ascending bids);

- generic or specific lots; and

- individual lot or package (combinatorial) bidding.

10.28 We proposed four possible formats if an auction was deemed appropriate:

- a “standard” simultaneous, multiple round, ascending auction (SMRA) with predefined lots, which could be augmented by either limited withdrawals or augmented switching;

- an SMRA with predefined lots and package bidding;

- a clock/sealed bid hybrid, with each lot as a unique category (equivalent to having predefined lots); or

- a clock/sealed bid hybrid with a more limited number of categories of generic lot.

10.29 We sought views on which of these formats would be most suitable.

Consultation responses

10.30 Most respondents did not, or felt unable to, respond on this issue. The vast majority of the 89 responses that we received either offered no firm view or did not support an auction at all, calling on us to resist a repeat of the 3G auction in 2000. There were also calls to reserve spectrum on policy grounds for particular uses (e.g. local television, PMSE and DTT services in HD) before any auction of the remainder took place.

10.31 No one format was favoured by those respondents who did express a view. Many needed more information before they could comment, while others believed that the format depended on packaging. A simple, flexible approach was, however, supported.

10.32 Some respondents thought that the auction design should incorporate a stage to assess broader social value to assist bidders seeking to provide such services.

10.33 OSAB raised the need to better educate industry and the public about auctions to increase confidence in them and counter the view that they sought to maximise revenues (a view expressed by many individual respondents). It also raised potential concerns about a UK-centric approach and accepting bids from participants in countries (particularly EU Member States) that did not offer reciprocal opportunities to UK organisations.

10.34 It was noted that competitors for cleared and interleaved spectrum might be quite different and that this should be reflected in our proposals. It was also suggested that local television operators would have difficulty prevailing over MNOs if they competed for the same packages of interleaved spectrum.

Our response

10.35 The suitability of auctions and the arguments for reserving spectrum for specific uses are considered earlier in this statement.

10.36 Other issues raised on auction design will inform our consultations on detailed award design.

London Olympics

10.37 On 6 July 2005, London was chosen to host the 2012 Olympic Games and Paralympic Games. These will take place between 27 July and 9 September 2012 at some 35 competition venues in London and across the UK.

10.38 As part of London's bid for the Olympics, the Government gave two binding guarantees to the International Olympic Committee, covering:

- the allocation of the spectrum required for the organisation of the Olympics; and
- the waiving of fees payable by members of the Olympic family for the allocated spectrum required for the Games.

10.39 We are responsible for organising a full spectrum plan for the London Olympics and for arranging all the spectrum licences in good time in support of the plan.

10.40 The London Organising Committee of the Olympic Games and Paralympic Games will be working closely with its partners to ensure that it uses existing and emerging technologies in innovative and powerful ways. Wireless technologies, in particular, will play a fundamental role both in the build-up to and during the London Olympics. We therefore expect that the Games will see an increase in spectrum requirements, principally in London, where spectrum is already heavily used. Meeting these requirements, and hence the Government guarantees, will be a complex task. We are also concerned to minimise any negative impact on other spectrum users and, ultimately, on citizens and consumers who benefit from those uses.

10.41 It is for these reasons that we started the task of spectrum planning for the London Olympics in 2006, some six years before they begin. Our work to date is described in a discussion document that we published on 30 November 2007.[46] At the core of the issues that it addresses is identifying what applications at the Games might require spectrum and whether they could use spectrum more efficiently. Understanding these factors will assist us in constructing a draft spectrum plan, on which we expect to consult after the 2008 Beijing Olympics . The discussion document seeks information and views to aid our understanding.

10.42 The document does not address the supply of spectrum to meet the requirements of the London Olympics. Many of the details are heavily dependent on the nature and extent of the requirements to be met. But we have considered the role that the digital dividend could play. In particular, there might be a case for:

- holding back some cleared spectrum from new uses in London until after the Games, allowing us to meet the requirements for audio links (principally wireless microphones, in ear monitors and talkback systems). This would involve a delay in making spectrum available for other uses of only a few months given DSO in London is scheduled to take place in the first half of 2012; and

- retaining a power of direction over the band manager for interleaved spectrum with PMSE obligations so that we can access the spectrum awarded to it to meet the requirements for audio links and require its assistance with spectrum planning and licensing where necessary.

10.43 We will explore these issues further when consulting on detailed award design. Responses will inform both the terms of the digital dividend awards in question and our draft spectrum plan for the London Olympics.

10.44 The Government has given similar guarantees on spectrum for the Glasgow 2014 Commonwealth Games. We will also take these into account.

Multiplex licensing

10.45 The DDR consultation document noted that the Communications Act gave us the power to operate a simpler and more flexible regime, solely under the Wireless Telegraphy Act 2006,[47] for licensing multiplexes carrying broadcast services. It indicated that that we expected to use this new regime in licensing any new multiplexes using the digital dividend, removing the requirement to hold a licence under the Broadcasting Act 1996.[48]

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[46] www.ofcom.org.uk/consult/condocs/spectrum2012/condoc.pdf.
[47] www.opsi.gov.uk/acts/acts2006/pdf/ukpga_20060036_en.pdf.
[48] www.opsi.gov.uk/acts/acts1996/plain/ukpga_19960055_en.

10.46 We still expect to use this new regime for the digital dividend, but we have considered whether it would be desirable to retain some limited elements of the Broadcasting Act regime. We will set out proposals when consulting on detailed award design, for instance to disqualify certain groups from operating a television or radio multiplex using the digital dividend and to address interoperability between the existing DTT platform and any new television multiplexes using this spectrum.

Crown Dependencies

10.47 The Crown Dependencies—Guernsey, Jersey and the Isle of Man—are independent jurisdictions that can choose to adopt certain UK laws, reflecting their internal policies. Under the Wireless Telegraphy Act, we allocate and assign spectrum on their behalf, taking their interests into account. We also represent them internationally in bodies such as the ITU. Consequently, we help to resolve interference issues at both the national and the international levels.

10.48 Each of the Crown Dependencies has adopted certain parts of the Wireless Telegraphy Act. Both auctions and trading are permissible in Guernsey but only auctions in Jersey and the Isle of Man. Jersey has decided to introduce trading in the near future.

10.49 We have discussed the DDR at length with the Crown Dependencies. Table 14 summarises their preferences for inclusion or otherwise in the licences that we will award for the digital dividend. We will publish our proposals when consulting on detailed award design.

Table 14. Crown Dependency involvement in the digital dividend awards

	Guernsey	Jersey	Isle of Man
Cleared spectrum	Include	Include	Separate award
Interleaved channels 61 and 62	Include	Include	Separate award
Packages suitable for local television	Consult	Consult	Separate award
Package with PMSE obligations	Include	Include	Include

Conclusion

10.50 Our consultations on detailed award design will set out proposals in respect of:

- technical constraints;
- usage rights and obligations, particularly relating to competition;
- auction design;
- the London Olympics;
- multiplex licensing; and
- the Crown Dependencies.

Section 11

Next steps

Introduction

11.1 This section sets out the next steps in the DDR.

Consultations on detailed award design

11.2 We will consult on the detailed design of the digital dividend awards in spring 2008. We anticipate publishing consultation documents covering:

- the award of cleared spectrum, channel 36 and interleaved channels 61 and 62 (where available);
- the award of geographic packages of interleaved spectrum suitable but not reserved for local television; and
- the award of a package of interleaved spectrum with PMSE obligations to a band manager by beauty contest.

11.3 If not simultaneous, these consultations will be published very close to each other given the close links between the different awards. Before publication, we will work with key public bodies to improve their understanding of the interaction between the digital dividend and their policy responsibilities so that they can better respond.

Awards

11.4 We expect to publish an information memorandum and draft regulations setting the rules for each award during autumn 2008. We would bring the final regulations for each award into force in time for us to hold them in late 2008 or early 2009.

11.5 We hope to issue licences for use of the digital dividend during the first half of 2009.

Timetables

11.6 Tables 15, 16 and 17 set out the current timetables for the three digital dividend awards. These are subject to factors outside our control and may therefore change during the course of the rest of the DDR.

Table 15. Timetable for awarding a package of interleaved spectrum with PMSE obligations to a band manager by beauty contest

Spring 2008	Consultation on award design
Summer 2008	Consultation closes
Autumn 2008	Invitations to tender
Late 2008	Award

Table 16. Timetable for awarding geographic packages of interleaved spectrum suitable for local television

Spring 2008	Consultation on award design
Summer 2008	Consultation closes
Autumn 2008	Information memorandum and draft regulations
Late 2008	Awards in Border, Granada, West Country and Wales
Summer 2009	Remaining awards

Table 17. Timetable for awarding cleared spectrum, channel 36 and interleaved channels 61 and 62

Spring 2008	Consultation on detailed award design
Summer 2008	Consultation closes
Late 2008	Information memorandum and draft regulations
Summer 2009	Award

Annex 1

Glossary of abbreviations

3G	Third generation mobile phone standards and technology
ACNI	Advisory Committee for Northern Ireland
ACOD	Advisory Committee for Older and Disabled People
ACS	Advisory Committee for Scotland
ACW	Advisory Committee for Wales
AIP	Administered Incentive Pricing
ARCEP	Autorité de régulation des communications électroniques et des postes
CEPT	European Conference of Postal and Telecommunications Administrations
COCOM	Communications Committee
DDR	Digital Dividend Review
DECT	Digital Enhanced Cordless Telecommunications
DSO	Digital switchover
DTT	Digital terrestrial television
DVB-H	Digital Video Broadcast—Handheld
DVB-T/-T2	Digital Video Broadcast—Terrestrial
ECS	Electronic communications services
EU	European Union
FCC	Federal Communications Commission
GDP	Gross domestic product
GE-06	Geneva 2006 Agreement
GHz	Gigahertz
GSM	Global System for Mobile
HD	High definition
ICT	Information and communications technology
IMT	International Mobile Telecommunications

ITU	International Telecommunication Union
LEFR	Licence Exemption Framework Review
MHz	Megahertz
MNO	Mobile network operator
MOD	Ministry of Defence
NPV	Net present value
OCP	Ofcom Consumer Panel
OSAB	Ofcom Spectrum Advisory Board
PAL	Phase Alternating Line
PMR	Private mobile radio
PMSE	Programme-making and special events
PSB	Public service broadcaster/broadcasting
PVR	Personal video recorder
RFID	Radio-frequency identification
RSC	Radio Spectrum Committee
RSL	Restricted Service Licence
RSPG	Radio Spectrum Policy Group
SD	Standard definition
SFN	Single-frequency network
SFR	Spectrum Framework Review
SMRA	Simultaneous, multiple-round, ascending auction
TG4	Task Group 4
UHF	Ultra High Frequency
UWB	Ultra-wideband
WAPECS	Wireless access policy for electronic communications services
WiMAX	Worldwide Interoperability for Microwave Access
WRC-07	World Radiocommunication Conference 2007

Attachment 3

Digital Dividend Review: geographic interleaved awards 470 - 550 MHz and 630 - 790 MHz

Consultation on detailed award design

Consultation

Publication date: 12 June 2008

Closing Date for Responses: 21 August 2008

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Section 1

Executive summary

Introduction

1.1 This consultation document sets out our proposals for the award of part of the spectrum freed up for new uses by digital switchover (DSO). We call the spectrum made available by DSO the 'digital dividend'. The digital dividend has been the focus of our Digital Dividend Review (DDR) since we launched it in 2005[1].

1.2 There are two distinct categories of spectrum in the digital dividend: the spectrum that by 2012 will be cleared of television transmissions (the cleared spectrum); and capacity available within the 256 MHz of spectrum that will be used to carry the six digital terrestrial television (DTT) multiplexes (the existing DTT multiplexes)[2] after DSO. We are concerned in this document with the second type, which we call the geographic interleaved spectrum. It is so called because for each channel within this spectrum there are geographic areas where not all of the channels will be used for existing DTT and in those areas these unused channels may be used for other services.

1.3 This document is one of three separate consultations we are publishing on implementing the digital dividend awards. Two other consultation documents set out our proposals on the auction for the cleared spectrum[3] (published 6 June 2008) and on the 'beauty contest' for the part of the interleaved spectrum to be administered by a band manager with obligations to Programme Making and Special Events (PMSE) users (to be published later in the summer).

1.4 In our work on the DDR we have found potential demand for digital dividend spectrum for local television. In a statement we published in December 2007 ('the DDR statement')[4] we set out our decisions on the strategic approach we would take to the release of the digital dividend. We considered arguments made to reserve spectrum exclusively for local television but decided against this. Among other things, we considered that this might displace other high value uses for the spectrum and would reduce incentives for efficient spectrum use.

1.5 We have also identified other potential uses for the geographic interleaved spectrum, including new DTT services over a wider area, mobile broadband and PMSE. We

[1] More information about the DDR along with previous DDR publications is available on the Ofcom website at http://www.ofcom.org.uk/radiocomms/ddr/

[2] The existing DTT multiplexes are the six multiplexes which currently make up the digital terrestrial television platform in the UK, commonly referred to as Freeview, comprising Multiplex 1 (operated by the BBC), Multiplex 2 (operated by Digital 3&4 Ltd, jointly controlled by the Channel 3 licensees and Channel 4), Multiplex A (operated by SDN Ltd, controlled by ITV plc), Multiplex B (operated by BBC Free to View Ltd), and Multiplexes C and D (operated by National Grid Wireless Ltd). In the context of DSO, the three multiplexes operated by the BBC (Multiplexes 1 and B) and Digital 3&4 (Multiplex 2) are called the PSB multiplexes, and the three remaining multiplexes (Multiplexes A, C and D) are called the commercial multiplexes. After DSO, at least 98.5 per cent of UK households will be able to receive the three PSB multiplexes. The coverage of the three commercial multiplexes is expected to reach around 90 per cent of households.

[3] *Digital Dividend Review: 550-630 MHz and 790-854 MHz. Consultation on detailed award design*, Ofcom, 6 June 2008, http://www.ofcom.org.uk/consult/condocs/clearedaward/condoc.pdf

[4] *Digital Dividend Review, A statement on our approach to awarding the digital dividend*, Ofcom, 13 December 2007, http://www.ofcom.org.uk/consult/condocs/ddr/statement/statement.pdf

said in the DDR statement that we had decided therefore to award the geographic interleaved spectrum in lots that would be suitable for local TV but would not restrict their use to this service.

1.6 In the DDR statement we proposed that the spectrum to be awarded would be packaged in geographic lots, based on main TV transmission sites serving major towns and cities. We set out an indicative list of 25 possible locations across the UK where we expected that interest would justify offering such lots and/or where local television operators were already licensed to provide an analogue service. We said we would be prepared to consider other locations where there was evidence of demand.

1.7 We also said in the DDR statement that we would award the first set of spectrum lots for those locations where existing restricted television service licence (RTSL) operators need, prior to DSO, sufficient clarity about their options for future spectrum access. These are channels at the Caldbeck, Winter Hill and Wenvoe transmission sites for Carlisle, Manchester and Cardiff, respectively.

This document

1.8 The geographic interleaved spectrum that we propose to award can cover a substantial area of the UK. In this document we put forward 81 transmission sites for which we might award spectrum. If used for DTT, depending on the technology employed, they could in aggregate cover around 80 per cent of the UK population.

1.9 Use of the spectrum for new DTT services could impact on existing DTT services after DSO. We have had to consider both the level of protection that existing services should enjoy and the desirability of allowing a reasonable level of coverage for new services. The technical licence conditions we propose for the new licences aim to provide a reasonable balance between maximising the economic value of the spectrum and minimising the potential disruption to reception of existing DTT multiplexes.

1.10 In our studies of these transmission sites we have found that there are channels available that offer a range of options for coverage. There are those that provide good all round geographic coverage over a wide area. Others provide more limited directional coverage but are still potentially commercially significant. We have categorised these respectively as ‘large’ and ‘medium’ spectrum lots in our list of sites for award. At each of the 25 sites we identified in the DDR statement we could offer both categories of lots. At the other candidate sites we propose to offer ‘medium’ or ‘small’ lots (which provide a smaller or more localised coverage area).

1.11 We are proposing spectrum awards designed to meet the needs of different types of potential interested bidders.

- **Phased awards** of ‘medium’ and ‘small’ lots by auction would take place to match the DSO timetable. The first award would be in late 2008 or early 2009 of lots for Caldbeck, Winter Hill and Wenvoe, i.e. sites that cover Carlisle, Manchester and Cardiff where there are existing RTSLs that are subject to DSO by early 2010. There could be further awards of ‘medium’ and ‘small’ lots in early 2010 and another batch in early 2011 ahead of the latter stages of the DSO timetable.

- A **combined award** of ‘large’ lots in the locations identified as being most suitable for aggregation, i.e. using a number of lots together for one service, if that is what bidders wish to do. This award would take place after the award of the cleared spectrum. The award of the cleared spectrum is currently scheduled to begin in summer 2009. Therefore the combined award of geographic interleaved lots could potentially start in late 2009. It would be designed to facilitate the requirements of those operators wishing to develop services in a number of locations. It would be based on channels at the 25 locations we identified in the DDR statement, possibly with additional locations where there is sufficient evidence of demand. We propose to offer one 8 MHz channel per location, with the frequency at each location chosen in order to maximize possibilities for geographic aggregation.

1.12 We have identified 81 transmission sites and channels that could be included in the phased awards (see Table 6.1). In light of expressions of interest that we are seeking (see paragraphs 6.48-6.54) we will finalise the list before inviting applications to take part in the auctions.

1.13 We have considered which auction formats would be most suitable for the awards. Our proposals are:

- for the phased awards, a single unit ascending bid auction for each lot, i.e. each location and its related channel;

- for the combined award, either a combinatorial clock auction or a simultaneous multiple round auction, though we have a preference for the former.

1.14 In this document, we set out the auction process and main rules that we propose for the initial phased awards and invite stakeholders' comments on them. We will take the comments received into account in finalising the award process and the rules. Draft award regulations will set out the rules in full and be subject to a separate, statutory consultation.

1.15 The wireless telegraphy licences that we award following the auctions will contain both technical and non-technical conditions. The technical conditions we propose are designed to protect the existing DTT multiplexes from harmful interference from new services after DSO. Since we see provision of DTT as the most likely use of the spectrum we are proposing to include technical conditions appropriate to DTT as basic technical conditions (see paragraphs 8.8-8.16). These may not be suitable for other new non-DTT services and if, after a licence award, the licensee wishes to provide other services we will consider variation of the technical conditions. Our proposed non-technical conditions cover, among other things, multiplex ownership and interoperability (to apply when the spectrum is being used as a DTT multiplex, see paragraphs 9.7 to 9.24). The spectrum rights conferred by the licences will be fully tradable. The licences will have an indefinite term with an initial period ending in 2026, during which time Ofcom's powers to revoke will be limited.

1.16 It is important that the geographic interleaved award promotes both competition and efficiency in the award and use of the geographic interleaved spectrum. We believe that our overall award process will go a long way towards this. We have also considered whether there is a case for us to go further in terms of putting in place general safeguards or other interventions to secure these goals. We conclude that one general intervention may be appropriate, namely an information provision that may help to facilitate an efficient secondary market. We do not consider that there are any specific issues that require intervention or remedy in respect of the geographic interleaved spectrum.

Summary of proposals

1.17 The table below sets out in summary form our proposals for this award.

Table 1.1 Summary of proposals for the geographic interleaved awards

Available Spectrum	**Our proposals**
Spectrum included in the geographic interleaved awards	The geographic interleaved spectrum is the spectrum that will be available on a geographic basis within the 256 MHz of spectrum (470-550 MHz and 630-806 MHz) that will be used to carry the existing DTT multiplexes after DSO. It is proposed that channels 61 and 62 (790-806 MHz) will be awarded with the cleared spectrum. We propose that the remaining 240 MHz will be awarded by auction on a geographic basis, as detailed in this document.
Timing	**Our proposals**
Timing of spectrum awards	We propose a series of awards: • the initial phased award of 'medium' lots in late 2008 or early 2009 of lots for Caldbeck, Winter Hill and Wenvoe, i.e. sites which cover locations where there are existing RTSL operators that are subject to DSO by early 2010; • a combined award of 'large' lots in the locations identified as being most suitable for aggregation, including the 25 sites identified in the DDR statement (entries 1 to 25 in the list in Table 6.1). This award would take place soon after the award of the cleared spectrum, which is scheduled to begin in summer 2009. • possible phased awards of 'medium' and 'small' lots in early 2010 and in early 2011 ahead of the latter stages of the DSO timetable, subject to evidence of demand. This timing is designed to help those wishing to develop local TV services to arrange funding.
Lots to be included in the awards	**Our proposals**
Lots to be defined by channel and geographic coverage	We propose that packaging of spectrum will be in 8 MHz lots (channels). We propose that the spectrum will be for geographically defined coverage areas. The first award will be of lots for Caldbeck,

	Winter Hill and Wenvoe. We propose that the combined award of 'large' lots will include the indicative list of 25 locations set out in the DDR statement. The lots included in the phased awards will be finalised in light of expressions of interest we receive. This document includes a list of 81 candidate transmission sites and channels that could be included in the phased awards (see Table 6.1). In light of expressions of interest we will finalise the list before inviting applications to take part in the awards in early 2010 and in early 2011. Annex 6 sets out the transmission sites and channels that may be included in each award and the phasing of awards.
Technical licence conditions (TLCs)	**Our proposals**
Type of TLCs	We propose to define the TLCs for the available spectrum in the form of block edge masks suitable for the provision of DTT. Where a licensee wishes to provide a service other than DTT we will consider varying the licence. This may require a TLC in the form of spectrum usage rights (SURs) and a 'protection clause' to protect the existing DTT multiplexes.
Balancing new DTT services with protection of existing DTT services	We propose that new DTT services should protect the best DTT coverage and recognise both where analogue aerials are directed and regional and national ITV boundaries. This is the 'median option' described and analysed in paragraphs 5.30 to 5.52.
Non- technical licence conditions	**Our proposals**
Multiplex ownership and interoperability	We propose to include certain restrictions on ownership in relation to use of geographic interleaved spectrum to operate new DTT multiplexes. These would reflect the similar regime under the Broadcasting Act (for example preventing religious or political bodies from holding licences for this purpose). We propose to facilitate technical interoperability between any new DTT services in geographic interleaved spectrum and existing DTT services.
Licence term	We propose that the licences will have an indefinite term with an initial term ending in 2026. During the initial term we will not have the power to revoke for spectrum management

	reasons. We would have the power to revoke the licence for spectrum management reasons at any time after the initial term, subject to giving the licensee five years notice. The notice may be given during the initial term which could lead to the licence being revoked at the end of the initial term.
Licence fees	The auction will determine the fees payable, subject to a reserve price. After the expiry of the initial term, if a licensee continues to hold its licence, there may be additional charges. In particular, to incentivise efficient use of the spectrum, we presently expect to charge AIP.
Spectrum trading	We propose that all licences in this award will be tradable. All types of trade - partial or total; concurrent or outright - will be permitted.
Non-technical restrictions	We propose that the licences will not contain any restrictions on the use to which the spectrum could be put, other than technical licence conditions.
Auction designs	**Our proposals**
Auction formats	For each stage we propose the following auction formats: • a single unit ascending bid auction for each lot for Caldbeck, Winter Hill and Wenvoe; • a combinatorial clock auction or simultaneous multiple round auction for the award of 'large' lots in the locations identified as being most suitable for aggregation – we express a preference for the former. • a single unit ascending bid auction for each lot in the phased awards of 'medium' and 'small' lots.
Main rules for the ascending bid auction of lots for Caldbeck, Winter Hill and Wenvoe	**Our proposals**
Qualification and activity rules	We are proposing that the nature of the rules and penalties relating to collusion and bidder association should be similar to those that we have put in place for other recent spectrum awards. As such, we would notify each applicant of the names and associates of all other applicants and set a date by which applicants must notify us as to whether any

	members of their bidder group are also associates of another applicant. We would also consider whether any members of one bidder group are also members of another bidder group.
Deposits	We propose to require deposits at a number of points in the process: • Applicants pay an initial deposit on the day designated for the submission of applications. Subject to the outcome of this consultation, we propose to set the level of the initial deposit at £10,000. • Before the auction starts we will require bidders to increase their deposits so that they are at least equal to the reserve price. • During the ascending bid stage we may ask bidders to make additional deposits to cover the amount of their bids.
Reserve price	Each lot available for award will carry a reserve price, below which it will not be sold. We propose to set for each lot a reserve price of £25,000.
Pace of the auction	We propose to retain discretion over the scheduling of primary bid rounds, which includes discretion over the number of rounds per day, together with retaining a level of discretion over round price increases in managing the duration of the auction.
Information policy	There is a range of options for releasing information in the ascending bid stage of the auction. We consider that full transparency would make for an efficient auction, with bidders receiving after each round full information on the bids all other bidders have made.
Payment terms	We propose to issue a licence to the winning bidder on full payment of its licence fee, i.e. the price determined through the auction process or reserve price where applicable.
Unsold licences	If a licence remains unsold at the end of the auction, either through an absence of bids or default, we will choose whatever course of action we consider appropriate at that time in accordance with our statutory duties.

Competition and efficient use of spectrum	**Our proposals**
‘Use it or lose it’ conditions	We propose not to impose any ‘use it or lose it’ conditions.
Roll-out obligations	We propose not to impose any roll-out obligations.
Open access conditions	We propose not to impose any open access conditions.
Information provision	We propose to include a licence condition requiring licensees to provide certain information regarding their use of the spectrum, which we would then publish in order to facilitate spectrum trading.
Spectrum caps	We propose not to impose any spectrum caps in respect of the geographic interleaved spectrum, either on a standalone basis or linked to the general safeguard spectrum cap of 50 MHz suggested for the cleared award.

Question 1. The executive summary sets out our proposals for the digital dividend geographic interleaved award. Do you agree with these proposals?

Next steps

1.18 This consultation closes on 21 August 2008. We are planning to hold a seminar on our proposals during the consultation period. More information about the next steps is set out in section 11 of this consultation.

Section 2

Introduction

2.1 The first phase of the DDR concluded with the publication of the DDR statement in December 2007. In it, we set out our decisions on the strategic approach we would take to the release of the UK's digital dividend – the spectrum freed up by DSO. Some of those key decisions were as follows:

- We confirmed our proposal to take a market-led approach to awarding the digital dividend and in doing so we decided to auction this spectrum, hence giving users flexibility to decide its optimum use. Auctions are the most open, transparent and non-discriminatory way of determining who should hold licences. A well designed auction process should have an efficient outcome, i.e. it should give the maximum flexibility for the market to determine the highest value use of the spectrum and the identity of the users.
- We decided not to intervene to reserve the spectrum for any particular use except for a single package of interleaved spectrum with obligations toward programme-making and special events (PMSE), which will be awarded via a beauty contest.
- We decided to auction geographic lots of interleaved spectrum suitable but not reserved for local television.
- We decided to include channel 36 in the award of the cleared spectrum and proposed to award the interleaved spectrum in channels 61 and 62 alongside this spectrum.
- We proposed to allow licence-exempt cognitive devices access to the interleaved spectrum but decided not to set aside any of the digital dividend exclusively for licence-exempt use or as an innovation reserve.
- Finally, we decided to continue with our timetable of awarding the digital dividend as soon as possible, with the auction for the first geographic interleaved lots proposed for later in 2008 or early 2009 and the remainder later in 2009.

2.2 On 6 June we published a consultation setting out our proposals on the detailed design of the award of the cleared spectrum (the 'cleared consultation')[5] and we will publish a further consultation on the award of a single lot of interleaved spectrum with obligations to PMSE users, later in the summer. Later this year, we will also publish a consultation document which will set out our proposals for giving licence-exempt cognitive devices access to the interleaved spectrum.

2.3 This document focuses on our proposals for the detailed design of the awards of geographic lots of interleaved spectrum (the geographic interleaved awards).

Different types of spectrum

2.4 There are several different types of spectrum available for release as part of the digital dividend. The principal distinction that we make is between the 'cleared' spectrum and the 'interleaved' spectrum. These categories are explained below.

[5] http://www.ofcom.org.uk/consult/condocs/clearedaward/

2.5 Cleared spectrum is spectrum that will be available on a UK-wide basis for new uses after DSO. Most of this spectrum comprises spectrum that will be cleared as a direct consequence of digital switchover, which will release 14 x 8 MHz channels, i.e. 112 MHz. This spectrum corresponds to channels 31-35, 37, 39-40 and 63-68.

2.6 We recognised at an early stage of the DDR that other UHF channels had potential to be cleared on a similar timeframe.

- In the DDR statement, we set out our decision to auction channel 36, which is expected to be cleared of its current use by April 2009, alongside the other cleared spectrum.

- We also made a proposal to include the interleaved spectrum in channels 61 and 62 in the cleared award.

- We decided that channel 69 should continue to be available for PMSE use throughout the UK on a licensed basis, and be included in the package of interleaved spectrum with obligations toward PMSE.

- Since the publication of the DDR statement, we have discussed future use of channel 38 with the Department for Innovation, Universities and Skills (DIUS) and the Science and Technology Facilities Council (STFC) - the bodies responsible for radio astronomy in the UK. They have decided to vacate the channel in time for the completion of DSO in 2012. Accordingly, we have decided to include channel 38 in the DDR cleared award.

2.7 In summary, the cleared award will include 128 MHz of spectrum available UK-wide in two blocks of 550-630 MHz (the lower sub-band) and 806-854 MHz (the upper sub-band) as well as 16 MHz of interleaved spectrum between 790-806 MHz. All of this spectrum will be fully available for new use by 2012 at the latest and is the subject of the cleared consultation[6].

2.8 The digital dividend also includes the 'interleaved' spectrum that will be available within the 256MHz of spectrum that will be used to carry the existing DTT multiplexes.

2.9 This interleaved spectrum is effectively 'white space' that will exist between transmission sites used for DTT multiplex coverage after DSO. Similar white space exists at present in analogue broadcasting. The white space arises because, in a multiple frequency network (MFN), any television channel (or multiplex) is carried on a number of different frequency channels around the country. On any given frequency channel used in this way there will be a geographical zone where use for high-power broadcasting is not possible because of the interference it would cause, but use for low power (non-DTT) applications is possible, provided these are carefully designed so as to be compatible with the primary, broadcast use. The white space of this kind that exists in the analogue world will disappear with the end of analogue transmission, but new white space will come into existence in between the expanded DTT networks.

2.10 Both categories of spectrum (cleared and geographic interleaved) comprise the digital dividend. The scope of the DDR extends to consideration of all of this available UHF spectrum.

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[6] Digital Dividend Review: 550-630 MHz and 790-854 MHz. Consultation on detailed award design, Ofcom, 6 June 2008, http://www.ofcom.org.uk/consult/condocs/clearedaward/

2.11 Figure 2.1 below shows these different categories of spectrum in the context of the wider use of UHF between 470 and 862MHz. There are different ways of referring to the spectrum in UHF– it is often referred to by 'channel number', each channel representing 8 MHz of spectrum. The spectrum can also be referred to using frequencies. For example, channel 21 occupies the frequency range 470-478 MHz.

Figure 2.1 The available UHF spectrum; channel numbers and frequency ranges

Channel	21	22	23	24	25	26	27	28	29	30	31	32
Frequency (MHz)	*470-478*	*478-486*	*486-494*	*494-502*	*502-510*	*510-518*	*518-526*	*526-534*	*534-542*	*542-550*	*550-558*	*558-566*
	33	34	35	36	37	38	39	40	41	42	43	44
	566-574	*574-582*	*582-590*	*590-598*	*598-606*	*606-614*	*614-622*	*622-630*	*630-638*	*638-646*	*646-654*	*654-662*
	45	46	47	48	49	50	51	52	53	54	55	56
	662-670	*670-678*	*678-686*	*686-694*	*694-702*	*702-710*	*710-718*	*718-726*	*726-734*	*734-742*	*742-750*	*750-758*
	57	58	59	60	61	62	63	64	65	66	67	68
	758-766	*766-774*	*774-782*	*782-790*	*790-798*	*798-806*	*806-814*	*814-822*	*822-830*	*830-838*	*838-846*	*846-854*
	69											
	854-862											

Interleaved spectrum

Currently airport radar - to be included in cleared award

Interleaved spectrum - to be included in cleared award

Cleared spectrum

Currently radio astronomy - to be included in cleared award

Spectrum currently reserved for PMSE

2.12 At the most fundamental level, spectrum is typically a substitutable resource – one channel or block of spectrum will be an alternative for other channels, to a greater or lesser degree depending on basic physical characteristics. But it is important to note that, in practice, the differences between channels can be greater than this. In particular, additional constraints on use can be created by international agreements and the need to prevent interference with other services within the UK. These constraints can vary significantly between channels.

The geographic interleaved awards

2.13 Our objective in awarding the digital dividend is to maximise the total value to society that using this spectrum is likely to generate over time. It is not our objective to manage the spectrum so as to raise revenue for the Exchequer – nor, given our statutory duties, is this a consideration that we take into account.

2.14 In the first phase of the DDR, we considered all potential sources of private and social value that could be delivered through the use of the DDR spectrum. We looked in detail at citizen and consumer interests in relation to all the likely uses of the spectrum. We undertook two major rounds of market research using a variety of techniques to discover the opinions of citizens and consumers on the options for using the spectrum. We carried out extensive technical research and detailed economic analysis and modelling. We also gave careful consideration to hundreds of consultation responses in order to finalise our policy approach to the release of this valuable spectrum. All of this helped us decide on the approach to the award of DDR spectrum which we believe best meets our statutory duties and objective for the DDR.

2.15 In the DDR statement, we explained our intention to award one or two geographic channels of interleaved spectrum suitable but not reserved for local TV in about 25 locations with known or likely demand for this use. We looked at the level of population coverage that might be required for a local TV service to be commercially viable as well as areas where there are existing Restricted Television Service Licences (RTSLs) for local TV. We considered adding further locations identified by potential providers, including community operators.

2.16 Since we published the DDR statement, in relation to this award we have:

- informally sought views from stakeholders on the locations of channels or lots to be made available via auction. As a result of this process we have decided to add a number of additional sites to our proposed list; and

- carried out further technical research into the impact of new services in the interleaved spectrum on existing DTT services. Consequently, we propose to modify the previous technical criteria that new services would need to respect in order to operate in the interleaved spectrum.

2.17 We are now consulting on possible locations in this next phase of the DDR. The sites we have identified are set out in Table 6.1. We invite views on whether to add more sites to, or indeed subtract sites from, this list by inviting interested parties to provide further evidence of demand where appropriate.

2.18 In this document we specifically consider:

- the most likely potential uses of the spectrum and the possibilities for combining lots to match cultural and/or administrative boundaries;

- the definition of spectrum rights and obligations which best reflect the likely demand for the spectrum and the specific technical constraints on the spectrum;

- the selection of auction formats and rules which provide the best fit for the available geographic interleaved spectrum, enable bidders to express their true value for the spectrum and encourage innovation in the form of new entry, new services and new technologies;

- the choice of technical licence conditions which provide maximum flexibility to implement different potential uses of the spectrum while affording sufficient protection for existing and new users of the spectrum from harmful interference, thereby preserving the inherent value of this natural resource;

- the choice of non-technical usage rights and obligations which will apply to licensees, including the licence term and the ability to trade spectrum, to provide certainty of tenure for winners of spectrum and enable maximum flexibility for the spectrum to pass to those who value it most over the course of time[7];

- the design of the awards that can best promote competition and innovation in downstream markets and guarding against the possibility of anti-competitive behaviour.

[7] We discuss possible variations of the licence in paragraphs 8.17 to 8.18.

Structure of this document

2.19 This document is structured as follows:

- In section 3, we set out the legal and regulatory framework within which we operate.

- In section 4, we explain our understanding of the likely demand and potential uses of the spectrum.

- In section 5, we set out our assessment of the possible geographic coverage and implications of new DTT services using the spectrum to be awarded, and the possibilities for combining lots to match cultural and/or administrative boundaries.

- In section 6, we make proposals for the types of spectrum lots which best reflect the likely demand for the spectrum and the specific technical constraints on the spectrum.

- In section 7, we make proposals for auction formats and rules which provide the best fit for the available lots of spectrum proposed in section 6.

- In section 8, we set out our assessment of the technical licence conditions that we propose to apply to this spectrum.

- In section 9, we set out the non-technical licence conditions we propose to include in the Wireless Telegraphy Act Licences that we will award to successful bidders following the auctions of this spectrum.

- In section 10, we explain our approach to competition and efficiency, how our general approach to awarding and managing spectrum is designed to promote both competition and efficiency and how this approach should be applied in the context of the geographic interleaved awards.

- In section 11, we set out the next steps for these awards.

Section 3

Legal and regulatory framework

3.1 In this section, we describe our functions, duties and objectives as they relate to these awards. We also provide a brief overview of the international regulatory provisions that impact on the potential future uses of the digital dividend.

Ofcom's duties and objectives

3.2 We make decisions within a framework defined in European Union (EU) and UK law. This sets out overarching general duties, which apply across all our functions, below which sit a number of specific duties[8].

The duties imposed by the Communications Act 2003

3.3 Section 3 of the Communications Act sets out our general duties and provides that our principal duties are:

- to further the interests of citizens in relation to communications matters; and
- to further the interests of consumers in relevant markets, where appropriate by promoting competition.

3.4 In securing the above duties, we are required to secure among other things the optimal use for wireless telegraphy of the electro-magnetic spectrum and the availability throughout the UK of a wide range of electronic communication services and to have regard to the different needs and interests of everyone who may wish to use the spectrum for wireless telegraphy.

3.5 Section 3(3) of the Communications Act provides that in performing our principal duties, we must in all cases have regard to the principles of transparency, accountability, proportionality and consistency as well as ensure that our actions are targeted only at cases in which action is needed.

3.6 Section 3(4) of the Communications Act requires us in performing our principal duties, to have regard to a number of factors as appropriate, including the desirability of promoting competition, encouraging investment and innovation in relevant markets and encouraging the availability and use of high speed data transfer services throughout the UK.

3.7 Where there is a conflict between the duties, priority must be given to the European Community requirements set out in section 4.

European Community requirements

3.8 Section 4 of the Communications Act implements article 8 (policy objectives and regulatory principles) of the Framework Directive[9]. This sets out objectives that

[8] See Annex 6 of the DDR statement for a more detailed overview of the statutory duties relevant to the DDR.

[9] Directive 2002/21/EC of the European Parliament and of the Council of 7 March 2002, on a common regulatory framework for electronic communications networks and services (Framework Directive), http://eur-lex.europa.eu/pri/en/oj/dat/2002/l_108/l_10820020424en00330050.pdf

national regulatory authorities must take all reasonable steps to achieve. These include the promotion of competition in the provision of electronic communications networks and services by, among other things, encouraging efficient investment in infrastructure and promoting innovation, and encouraging efficient use of radio frequencies; and contributing to the development of the internal market by, among other things, removing obstacles to the provision of electronic communications networks and services at a European level, encouraging the interoperability of pan-European services and ensuring that, in similar circumstances, there is no discrimination in the treatment of undertakings providing electronic communications networks and services.

3.9 Article 8 also requires EU Member States to ensure that in carrying out their regulatory tasks, national regulatory authorities take the utmost account of the desirability of making regulations technologically neutral.

Our duties when carrying out our spectrum functions

3.10 In carrying out our spectrum functions, we have a duty under section 3 of the Wireless Telegraphy Act 2006 to have regard in particular to:

a) the extent to which the spectrum is available for use or further use, for wireless telegraphy;

b) the demand for use of that spectrum for wireless telegraphy; and

c) the demand that is likely to arise in future for the use of that spectrum for wireless telegraphy.

3.11 We also have a duty to have regard, in particular, to the desirability of promoting:

a) the efficient management and use of the spectrum for wireless telegraphy;

b) the economic and other benefits that may arise from the use of wireless telegraphy;

c) the development of innovative services; and

d) competition in the provision of electronic communications services.

3.12 Where it appears to us that any of our duties in section 3 of the Wireless Telegraphy Act conflict with one or more of our general duties under sections 3 to 6 of the Communications Act, priority must be given to our duties under the latter. Section 5 of the Communications Act concerns our obligation to carry out our functions in accordance with any directions made by the Secretary of State. Section 6 concerns our duties to review regulatory burdens.

Granting Wireless Telegraphy Act licences

3.13 The Wireless Telegraphy Act sets out our legal power to grant wireless telegraphy licences. Section 8(1) makes it an offence for any person to establish or use any station for wireless telegraphy or to install or use any apparatus for wireless telegraphy except under and in accordance with a licence granted by us under that section (a wireless telegraphy licence).

3.14 Section 9(1) of the Wireless Telegraphy Act gives us the power to grant wireless telegraphy licences subject to such terms as we think fit.

3.15 However, our broad discretion in relation to the terms that can be imposed in a wireless telegraphy licence is subject to the rule that we must impose only those terms that we are satisfied are objectively justifiable in relation to the networks and services to which they relate, not unduly discriminatory and proportionate and transparent as to what they are intended to achieve (see section 9(7)).

3.16 Under section 8(4) of the Wireless Telegraphy Act, we have the duty to exempt from licensing any use of wireless telegraphy apparatus that we consider is not likely to cause harmful interference. Licence-exemptions are granted by way of regulations made under section 8(3).

Providing for an auction of wireless telegraphy licences

3.17 Under Article 5(2) of the Authorisation Directive[10], when granting rights of use of radio frequencies (wireless telegraphy licences in the UK context), Member States must do so through open, transparent and non-discriminatory procedures.

3.18 Under Article 7(2) of the Authorisation Directive where the number of rights of use of radio frequencies needs to be limited, Member States' selection criteria must be objective, transparent, non-discriminatory and proportionate. Section 29 of the Wireless Telegraphy Act requires us to make an order setting out the criteria.

3.19 Within this context, we have the power under section 14 of the Wireless Telegraphy Act (having regard to the desirability of promoting the optimal use of the electromagnetic spectrum) to make regulations providing that applications for the grant of wireless telegraphy licences must be made in accordance with a procedure that involves the applicants making bids for licences (e.g. an auction).

3.20 We have broad powers under section 14 to make provision in regulations for the form of the licences and the auction procedure.

Charging fees for wireless telegraphy licences

3.21 Under Article 13 of the Authorisation Directive, any fees imposed for rights of use of radio frequencies must reflect the need to ensure the optimal use of the resources. Such fees must be objectively justifiable, transparent, non-discriminatory and proportionate in relation to their intended purpose and take into account the objectives set out in Article 8 of the Framework Directive.

3.22 Section 12 of the Wireless Telegraphy Act permits charging for wireless telegraphy licences by enabling us to prescribe in regulations sums payable for these licences. This power enables us to recover the cost of administering and managing wireless telegraphy licences. Section 13 of the Wireless Telegraphy Act permits us to recover sums greater than these if we think fit in the light (in particular) of the matters to which we must have regard under section 3 of that Act, including promoting the efficient management and use of the part of the electromagnetic spectrum available for wireless telegraphy.

[10] Directive 2002/20/EC of the European Parliament and of the Council of 7 March 2002 on the authorisation of electronic communications networks and services (Authorisation Directive), http://eur-lex.europa.eu/pri/en/oj/dat/2002/l_108/l_10820020424en00210032.pdf

3.23 The fees for most wireless telegraphy licences (including those fees that we set out in order to incentivise the efficient use of the spectrum) are set out in specific regulations. The current regulations are the Wireless Telegraphy (Licence Charges) Regulations 2005 (SI 2005/1378) as amended[11].

Objective for the DDR

3.24 Taking account of our duties and our spectrum management strategy, and as set out in the 2006 DDR consultation document[12] and the DDR statement, our objective for the DDR is to maximise the total value to society that using the digital dividend is likely to generate over time. It is emphatically not our objective to award the digital dividend to maximise revenue for the Exchequer.

International Regulatory framework for electronic communications

3.25 Spectrum management in the UK takes place within international frameworks set both globally and in the EU. Some international constraints arise from the UK's obligations as a member of the International Telecommunication Union (ITU) which is an agency of the United Nations.

The Geneva 06 agreement

3.26 A major ITU conference (The Regional Radio Conference, 'RRC-06') held in Geneva in 2006 agreed a plan allowing for the transition from analogue to digital broadcasting in Europe and other regions. This plan does not require the UK, or any other signatory, to license spectrum for digital television, but it does require the UK to protect uses of spectrum in other countries. Conversely, the UK has rights of protection from uses abroad.

3.27 The Regional Radio Conference 2006 (RRC-06) produced a new Agreement, which has the status of an international treaty (called the Geneva 2006 Agreement – 'GE-06') and was signed by 101 countries from Europe, Africa, and the Middle East. The Agreement came into force on 17 June 2007 but signatories agreed to apply its terms provisionally from 17 June 2006.

3.28 Under GE-06 the UK has been granted the right to assign specific frequencies for digital terrestrial broadcasting, at specific power levels to transmission sites at particular locations in the UK. These assignments are listed in a document called the Digital Plan ('the GE-06 plan'), which forms part of GE-06. Within the GE-06 plan, the UK obtained the rights to operate up to eight DTT multiplexes within the UHF spectrum. In each geographic area in the UK, the bulk of these frequencies will be used for the existing DTT multiplexes that are already planned to operate after DSO (three PSB multiplexes and three commercial multiplexes). Frequencies suitable for the two remaining multiplexes comprise the cleared spectrum. Neighbouring countries also secured assignments that they are expected to adopt as part of their switchover programmes.

3.29 Although GE-06 and the GE-06 plan are focussed predominantly on broadcasting services, it is possible to use the GE-06 plan entries for uses other than broadcasting. A large number of countries, including the UK and all of its neighbours,

[11] http://www.opsi.gov.uk/SI/si2006/20062894.htm

[12] *Digital Dividend Review. This document consults on the proposed approach to the award of the digital dividend spectrum (470-862MHz),* Ofcom, 19 December 2006. http://www.ofcom.org.uk/consult/condocs/ddr/ddrmain.pdf

signed a declaration formally stating that they may use their GE-06 plan rights for broadcasting or other terrestrial applications with characteristics that may be different from those appearing in the GE-06 plan, on the condition that this different use remains within the envelope of their GE-06 plan entries. Furthermore, this declaration provided an agreement that any such use will be afforded protection to the levels defined by the interfering field strengths as arising from their GE-06 plan entries, taking into account any relevant bilateral agreements[13].

3.30 It is also important to note that if the spectrum is used for digital terrestrial broadcasting or another use requiring high-powered transmitters at sites other than those specified in the GE-06 plan, then the user must ensure that the field strengths generated in other countries will be no greater than would be produced from assignments in the GE-06 plan. If these conditions are met these assignments will be protected from international interference by neighbouring countries under the GE-06, to the extent that assignments in the GE-06 plan would be protected.

3.31 The overall impact of the above provisions is that the UK has the flexibility to use the assignments in the GE-06 plan for any purpose as long as it does not cause more interference, or require more protection, than if it were used strictly in accordance with the GE-06 and the Plan. Any use of the digital dividend spectrum in the UK will have to comply with the international obligations arising from GE-06 and any subsequent bilateral agreements (see section 5/6).

The EU and other international developments

3.32 Spectrum management in the UK takes place within international frameworks set both globally and in the EU. Under the Radio Spectrum Decision[14], the European Commission (the 'Commission') can adopt Decisions governing spectrum use. This can be done in the interests of ensuring effective policy coordination and, where appropriate, harmonised conditions for spectrum use in the internal market. These Decisions are binding on Member States and can only be adopted by the Commission with the support of a qualified majority of them, convened as the Radio Spectrum Committee (RSC). We represent the UK at RSC under direction by the Government.

3.33 The Radio Spectrum Policy Group (RSPG) works in parallel with RSC and also draws its membership from Member States. Again, we represent the UK under direction by the Government. RSPG's role is to give strategic advice to the Commission on major questions of spectrum policy. It does this by adopting Opinions, which are not binding but can have significant influence as they represent the prevailing view of Member States.

3.34 Three recent developments are particularly relevant to the geographic interleaved awards.

[13] At the Regional Radiocommunication Conference in 2006, 53 countries signed a declaration, formally declaring that their administrations may use their digital Plan entries for broadcasting or other terrestrial applications with characteristics that may be different from those appearing in the Plan within the envelope of their digital Plan entries under the provisions of the GE-06 Agreement and the Radio Regulations, and that their administrations agree that any such use will be afforded protection to the levels defined by the interfering field strengths as arising from their digital Plan entries, taking into account any relevant bilateral agreements, This declaration is available in the Final Acts of the RRC.

[14] Decision No 676/2002/EC of the European Parliament and of the Council of 7 March 2002 on a regulatory framework for radio spectrum policy in the European Community (Radio Spectrum Decision), http://eur-lex.europa.eu/LexUriServ/site/en/oj/2002/l_108/l_10820020424en00010006.pdf.

3.35 First, the World Radiocommunication Conference 2007 (WRC-07) agreed in November 2007 to change the international Radiocommunication Regulations to make spectrum currently used for analogue television more flexible, in particular enabling mobile use.

3.36 This has limited direct effect on the UK because agreements with other European countries already give us substantial flexibility. But the indirect benefits of the agreement could be large, opening up the prospect that many more countries will make a digital dividend available for new wireless services. This will help to create global economies of scale for equipment, so reducing prices for UK consumers.

3.37 Second, also in November 2007, the Commission published a Communication on a common approach to the digital dividend in the Europe[15]. This recommends identifying common bands that can be optimised by enabling 'clusters' of services using a similar type of communications network: broadcasting, mobile multimedia and mobile broadband. These bands would be planned and harmonised in some form at EU level. The Communication was published at the same time as a package of proposals for amending the legislation defining the EU regulatory framework for electronic communications networks and services.

3.38 Third, the European Conference of Postal and Telecommunications Administrations (CEPT), in its response to an earlier Commission mandate on this issue, concluded that the preferred sub-band for the harmonised mobile broadband cluster proposed by the Commission is the upper part of the UHF band V and should include, as a minimum, channels 62-69 (798-862 MHz), as offering the best possibility for Europe-wide non-mandatory, non-exclusive harmonisation[16]. This same spectrum including channel 61 (thus expanding the range to 790-862MHz) was then subsequently the subject of decisions at WRC-07 to enhance flexibility for mobile usage.

3.39 Following a further Commission mandate, work continues within CEPT to identify common technical conditions and international coordination and channelling arrangements. These reports are expected to be available in draft form from the end of 2008, for final delivery by June 2009.

3.40 We expect the following key outputs in relation to the digital dividend to occur between now and March 2009:

- in June 2008, conclusions from the Council of Ministers on the Commission Communication;
- in September 2008, a resolution from the European Parliament on the Commission Communication; and
- In March 2009, draft proposals developed by CEPT in response to the most recent Commission mandate.

3.41 We will continue to contribute fully to EU discussions in the months to come and we believe that our proposals for the UK digital dividend are not in conflict with

[15] *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Reaping the full benefits of the digital dividend in Europe: A common approach to the use of the spectrum released by the digital switchover,* November 2007, http://ec.europa.eu/information_society/policy/ecomm/doc/library/proposals/com_dd_en.pdf

[16] http://ec.europa.eu/information_society/policy/radio_spectrum/activities/rsc_work/mandates/index_en.htm

discussions currently underway in the above fora. In the meantime, in line with the decision set out in the DDR statement, we believe it right to press ahead with the digital dividend awards in the interests of bringing benefits to UK citizens and consumers at the earliest possible date.

Section 4

Uses of the geographic interleaved spectrum

Introduction and summary

4.1 In order to both specify an approach to packaging and auction design that promotes competition and efficiency and to specify appropriate licence conditions we first need to understand the likely uses of the spectrum available.

4.2 Evidence collected to date suggests some services and technologies are more likely to use the digital dividend than others. In the first phase of the DDR, we conducted two major rounds of market research. We also received evidence from consultation responses, our technical research and economic modelling. Our analysis therefore focused closely on the most likely uses.

4.3 For the interleaved spectrum, the most likely uses that we identified were DTT services, PMSE services and cognitive devices (implications for the last two uses will be the subjects of separate consultations). There are also other potential uses, such as mobile broadband and mobile TV. These are generally thought to be more suited to the cleared spectrum but interleaved spectrum may be an acceptable substitute or, in some cases, complement.

4.4 In this section we:

- describe the potential and likely uses of the geographic interleaved packages; and
- summarise the most recent stakeholder research we have undertaken in this area.

DTT

4.5 The geographic interleaved spectrum could be used by multiplex operators interested in aggregating the lots in order to form a sub-UK wide multiplex or a multiplex based around a single UK nation (Northern Ireland, Wales or Scotland) or a wider English region. A broadcaster may also be interested in acquiring geographic interleaved spectrum to fill gaps in coverage in a DTT multiplex deployed in the cleared spectrum.

4.6 Alternatively, multiplex operators could bid for a number of geographic lots with a view to broadcasting the same content across a number of separate areas on a regional or sub-national basis. The content need not be locally orientated material.

4.7 A multiplex operator may also seek to aggregate a number of separate (and not necessarily contiguous) geographic lots to form a network of local TV stations, perhaps in a number of major cities, and/or create regional or national multiplexes at the sub-UK level.

4.8 An aggregated multiplex may provide additional opportunities for local TV or other operators to negotiate access to a video stream. But it will also be suitable for other non-local services or geographic services based on an area significantly broader than a local area.

Local TV

4.9 Local TV may be characterised as a TV service likely to serve a closely defined geographic area such as a city, a local authority district or a smaller area (e.g. a neighbourhood or housing estate). Transmission areas will typically be smaller than existing BBC and ITV regions. Local TV may be operated on a wholly commercial basis, as a not-for-profit community model, or as a combination of both.

4.10 In 2005 with the Department of Culture, Media and Sport (DCMS), we commissioned the consultancy Spectrum Strategy to assess the commercial viability of delivering local digital services to provide input into our consultation Digital Local[17]. Spectrum Strategy found that services delivered to urban areas and to smaller communities were not likely to be viable on a purely commercial basis. They considered that only local digital TV propositions serving large metropolitan areas were viable on a commercial basis, though they suggested that more favourable outcomes might be achieved if a network-affiliate model was adopted in which numerous local TV stations shared costs and jointly marketed their airtime. This work was recently reassessed by Phillipa Marks, a consultant, and in the light of more recent market research and evidence she concluded that Spectrum Strategy's conclusions were over-optimistic[18].

4.11 In the DDR statement we said that reserving spectrum would do little to improve the commercial business case for local TV given the high costs involved in producing content that viewers want to watch and the challenging business model of local TV in the UK. We concluded that in instances where there was broader social value for local TV the challenging commercial business case should be addressed by direct funding rather than by specifically reserving spectrum.

4.12 A small number of local TV services are currently licensed in analogue form under restricted television service licences (RTSLs), and there is now interest from these licensees in using the available geographic interleaved spectrum in these areas to offer local TV services in digital form via DTT. Examples of existing terrestrial local TV services include Channel M in Manchester (backed by Guardian Media Group), MATV in Leicester (a commercial operation targeting the city's South Asian community) and NvTv in Belfast (a not for profit community model funded by Northern Irish arts, education and training bodies). Channel M and MATV are also available via cable and satellite.

PMSE

4.13 Programme makers, commercial theatres and event organisers use spectrum to relay sound and picture data across relatively short distances. This allows, for example, wireless microphones to be used on stage in musical theatre, and at events such as Live 8 and T in the Park. Other major uses include in-ear monitoring equipment and talkback.

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[17] *Digital Local - Options for the future of local video content and interactive services*, Ofcom, 19 January 2006, http://www.ofcom.org.uk/tv/psb_review/digital_local/

[18] *Comments on the "Economics of Local Digital Audiovisual and Interactive Services", a paper for Ofcom and the DCMS by Spectrum Strategy*, 6 November 2007, Phillipa Marks, submitted to the Competition Commission. http://www.competition-commission.org.uk/Inquiries/ref2007/macquarie/pdf/prov_findings_working_paper_1.pdf

4.14 Audio links for PMSE (including wireless microphones, in-ear monitoring equipment and talkback) already use existing interleaved spectrum. In all cases, the use tends to be low power. Many PMSE uses require assured quality of service to guard against the risk of interference. The digital dividend is suitable for this use partly because these users have already invested in equipment that is tuned to work at the available UHF frequencies. Actual demand for PMSE use of the spectrum is expected to rise with time, particularly for special events. One spur to demand currently foreseen is the 2012 London Olympics.

4.15 We have decided to award most of the available interleaved spectrum by 'beauty contest' to a band manager, who will be required to make spectrum available for PMSE users. Further detailed proposals regarding PMSE will be contained in a separate consultation in relation to that award (the band manager award) to be published later in the summer. There may be interest from PMSE stakeholders in acquiring geographic interleaved spectrum via auction to supplement the spectrum available via band manager's primary award.

Mobile broadband

4.16 Mobile broadband comprises future cellular and Internet access services such as future evolutions of 3G cellular mobile, mobile WiMAX and the complete family of IMT technologies (previously known as IMT-2000 and IMT-Advanced). Our 2007 market research[19] indicated that improved mobile phone and mobile broadband services generate high value for citizens and consumers.

4.17 The operation of mobile broadband services in interleaved spectrum is still being investigated. If this is feasible - particularly for downlinks - geographic interleaved lots could provide new or extended access on a sub-UK basis, for example, in areas not served via fixed lines or existing wireless networks on higher frequencies.

Mobile TV

4.18 The DDR statement noted the suitability of the UHF bands for providing mobile TV. It noted the suitability of other spectrum, some of which, at L-Band (1452-1492 MHZ) has been awarded. We announced on 4 April 2008 plans to auction additional spectrum at 2.6 GHz later in 2008, with an expected application date in July. Since then T-Mobile and O2 have begun legal challenges of our decision to press ahead with the award. In light of this we have decided that it would be inappropriate to set the application date for July or August 2008. As soon as we are in a position to do so we will provide further information on the timing of the application and auction processes. Additionally, mobile multimedia services are already being offered over 3G.

4.19 According to the results of our 2007 market research, consumer interest in mobile TV appears to be lower than in other potential uses of the digital dividend, though a significant minority of consumers appear very interested. Additionally, mobile TV is a nascent service, so current consumer appeal may not fully reflect the future level of demand, and stakeholders have expressed a high level of interest in using the digital dividend to provide mobile TV. There is an interest in acquiring spectrum for this use among those with an established interest in mobile cellular service, and broadcasting. Interest is focused on acquiring cleared spectrum, but again, geographic interleaved lots could provide new or extended access on a sub-UK basis.

[19] http://www.ofcom.org.uk/radiocomms/ddr/documents/research07/

Summary of stakeholder research

4.20 In preparation for the second phase of the DDR, we have undertaken further focused stakeholder research to understand the services that potential users of the geographic interleaved spectrum will wish to provide, given that the sector and the technologies it uses are rapidly evolving. Stakeholders continued to identify the following services that they believe are most likely to be offered using the geographic interleaved spectrum:

- new DTT services aimed at a UK market in either Standard Definition (SD) or High Definition (HD); and
- new DTT services aimed at local markets (i.e. local TV).

4.21 This stakeholder research supports our view that we have identified the most likely uses of the geographic interleaved spectrum as DTT.

4.22 Of course, it is possible that more potential uses will emerge in future, as technology changes and innovators create new products. The benefits of these unknown uses could be as large as, or larger than, the benefits of uses that we can identify now. It may be that these technologies will not fit neatly into the spectrum lots that we are proposing for this award.

4.23 Our proposal to make these licences fully tradable should alleviate some concerns about our ability to ‘future proof’ the licences. The spectrum could be traded fully or partially. Partial trades could involve trading geographical or frequency parts of the licence. For example, if a future technology only required a 4 MHz bandwidth, and a licensed user of the 8 MHz channel that we are proposing to award could trade half of its licensed spectrum to another operator. In addition, we would consider applications to change technical conditions in licences as appropriate.

4.24 However, we acknowledge the importance of ensuring that the primary award (i.e. when the spectrum is first released to the market) delivers efficient outcomes based on current knowledge, and that these, in turn, deliver significant benefit to citizens and consumers in making the right choices. We consider that the time and cost involved in preparing the primary award will be justified by the benefits that it could bring.

Question 2. Do you have any comments on our assessment of the most likely uses of the geographic interleaved lots? Are there any potential uses which should be considered that we have not mentioned?

Licence-exempt cognitive devices’ access to the interleaved spectrum

4.25 In the DDR statement, we considered the use of interleaved spectrum for licence-exempt applications and proposed allowing cognitive devices access as long as we were satisfied that it would not cause harmful interference to licensed use of the interleaved spectrum.

4.26 We consider here which licensed uses of the interleaved spectrum we should specifically protect from harmful interference. Responses on this issue will inform a separate consultation on licence-exempt cognitive devices access to the interleaved spectrum, which we expect to publish later this year.

Cognitive devices

4.27 A cognitive device scans the available spectrum, determines which parts of it are currently unused and, as needed, makes use of this spectrum when it has information to transmit. Cognitive devices are often described as being particularly suited for high-bandwidth services such as home and business networks, community and campus networks and municipal Wi-Fi.

4.28 In the DDR statement, we considered whether the interleaved spectrum was usable for low-power and/or licence-exempt cognitive devices. We considered whether the characteristics of this spectrum made it suitable for this type of use, and we examined the merits both of allowing cognitive devices access and of a dedicated licence-exempt allocation. We concluded that reserving spectrum for licence-exempt use would not be appropriate, because of the very high opportunity costs in displacing potential licensed uses and the fact that potential licence-exempt uses could be accommodated more effectively in higher frequency spectrum. In contrast, we concluded that cognitive devices could make flexible use of the interleaved spectrum without causing harmful interference to licensed users, depending on the development of effective spectrum sensing technology.

4.29 In allowing licence-exempt cognitive devices access, it is important to specify a number of parameters so that cognitive devices do not interfere with licensed use. Key among these are the sensitivity of the cognitive device to detecting signals from other users and the power levels it is allowed to transmit. These parameters will be a key element for consultation.

Specifying services to protect

4.30 It is generally not possible to design a cognitive device to be able to detect and avoid any service that might be deployed in the future. As a result of this there is a need to specify in advance parameters for those services that could credibly be deployed in the interleaved spectrum and that cognitive devices should be specifically designed to avoid. It is important to strike the right balance between protecting valuable services while at the same time not imposing unnecessary restrictions on cognitive devices.

4.31 Equally, services that are not explicitly protected will not necessarily suffer harmful interference. Cognitive devices will tend to avoid spectrum in which they have detected signal energy. While they may be worse at detecting services to which they have not been tuned than those for which they have been specifically designed, some degree of protection will nevertheless be conferred. We also anticipate that, in most cases, harmful interference will be transitory as devices move past each other or turn on and off. For example, interference from cognitive devices to mobile television receivers may be less problematic than a reduction in signal strength experienced inside a building.

4.32 There is also a risk that new services will subsequently emerge that do merit protection. We considered this issue in the DDR statement and concluded that we needed to be mindful of the potential for access for cognitive devices to have a negative impact on the future usability of interleaved spectrum when specifying the parameters for this use.

4.33 Cognitive devices would need to ensure they did not cause harmful interference to DVB-T transmissions. We consider this should apply to licence holders irrespective of the geographic coverage of their services. We also expect to see DVB-T2[20] introduced in the near future and consider that such services should be protected from harmful interference.

4.34 Protection should also be afforded to PMSE use. This represents a broad category of technologies and applications. We suggest that protection be offered to currently available wireless microphones, in-ear monitors and talkback systems.

4.35 It is possible that other services, such as mobile television and two-way mobile, might be deployed in the interleaved spectrum. To determine whether to offer protection to such services we would need to consider the likelihood of the services being deployed and the value they might bring to users, compared to the reduction in value that would result from cognitive devices avoiding such services. We do not believe that there is currently enough information available to determine this quantitatively. However, we can examine the implications on cognitive devices of avoiding mobile television.

4.36 The key problem we envisage with cognitive devices and mobile television receivers is the possible interference caused when they are in proximity. It is possible that a mobile television receiver and a cognitive device might be within a few metres of each other (e.g. in a railway carriage). In this situation, modelling shows that even if the cognitive device detects a mobile television transmission and avoids using the channel as well as adjacent channels, interference can still result. This is because the out-of-band filtering of the mobile television handset may be insufficient to remove it. Only by restricting the transmit power of the cognitive device to levels of around 1 mW can interference be avoided. Such a low transmit power level would, in our view, render the cognitive device of little value.

4.37 Broadly, our conclusions are that mobile television and cognitive devices cannot coexist in the same spectrum unless the out-of-band performance of mobile television handsets is substantially improved above current specifications, by at least 20 dB. Hence, if we conclude that mobile television transmissions in the interleaved spectrum should be protected, we effectively prevent the use of cognitive devices. We should, therefore, only protect mobile television transmission if we have reasonable expectations that it will be deployed and will provide significant consumer value. We plan to consider this further in our forthcoming consultation on allowing cognitive devices licence-exempt access to the interleaved spectrum.

Question 3. Are there any other types of DTT transmission that should be protected from potential cognitive devices or other factors that we should take into account?

Question 4. Are there any potential future PMSE applications, other than currently available wireless microphones, in-ear monitors and talkback systems, that you consider should be protected from potential cognitive devices?

Question 5. Is there sufficient evidence to require protection for other services such as mobile television, bearing in mind the potentially negative implications of such protection for deployment of cognitive devices?

[20] DVB-T2 is an update of DVB-T, the current standard for DTT transmission which has been in use in the UK since 1998. DVB-T2 is currently undergoing standardisation and is expected to give at least a 30 per cent increase in multiplex capacity over the current standard whilst maintaining the same coverage.

Conclusions

4.38 In the light of responses to this consultation, we will form a judgement on the services that we believe should be explicitly protected from harmful interference from licence-exempt cognitive devices in the interleaved spectrum. We will issue a consultation later in the year detailing the required parameters for cognitive devices in order to achieve this.

4.39 Having considered possible uses of the geographic interleaved digital dividend and stakeholder research we have concluded that most interest in this spectrum is likely to come from parties wishing to provide DTT services. However, we acknowledge that there could be interest in acquiring geographic interleaved lots to provide other services including PMSE, mobile broadband and mobile television.

Section 5

Coverage and impact of new DTT services

Introduction and summary

5.1 Because DTT has emerged as the most likely use of the geographic interleaved spectrum (see paragraphs 4.5-4.24), we need to understand the coverage that they could achieve across and within the UK in order to identify an approach to packaging and auction design. The studies we commissioned found that a range of coverage scenarios are possible including UK- wide, nations, regions, metropolitan and communities. We need to understand the impact of such new DTT services on the coverage of the existing DTT multiplexes. We also need to decide to what extent we protect the existing DTT multiplexes and reduce risk of disruption to future reception while balancing the usability of the geographical interleaved lots for new services.

5.2 In this section, we:

- describe the potential coverage for new DTT services; and
- describe the potential impact on existing DTT services and set out proposals on the appropriate level of protection.

Potential coverage for new DTT services

5.3 As set out in section 4, a variety of applications can potentially use geographic interleaved spectrum to deliver services. This subsection looks in more detail at the potential coverage that could be achieved by new DTT services at different geographic levels. We focus on DTT for two interrelated reasons:

- we believe that it is the most likely use of the geographic interleaved spectrum in its own right rather than as providing supplementary capacity to other spectrum holdings; and
- we have found it both necessary and desirable to assess coverage in more detail to further inform our own and potential operators' understanding of the possibilities.

5.4 The following subsections are by no means exhaustive in describing how geographic interleaved spectrum could be used to provide new DTT services, but we believe that they are broadly representative of the range of possibilities. Please note that the predicted coverage and figures provided are indicative only.

Terrestrial television transmission

5.5 Terrestrial television is broadcast from 80 medium to high power transmission sites and over 1,000 lower to medium power relay transmission sites distributed throughout the UK. The main transmission sites are generally high power, located on high tower sites and cover large geographical areas (typically 60km radius) with high population. The relays generally operate at medium to low power using shorter masts, with coverage ranging from towns and cities to small communities.

5.6 We propose to group potential auction lots, given the existing transmission infrastructure, as follows:

- large lots – main transmission sites that offer widespread geographical and/or high population coverage.
- medium lots – main transmission sites and relay transmission sites that offer more targeted, significant population coverage.
- small lots – relay transmission sites that offer localised geographical and population coverage.

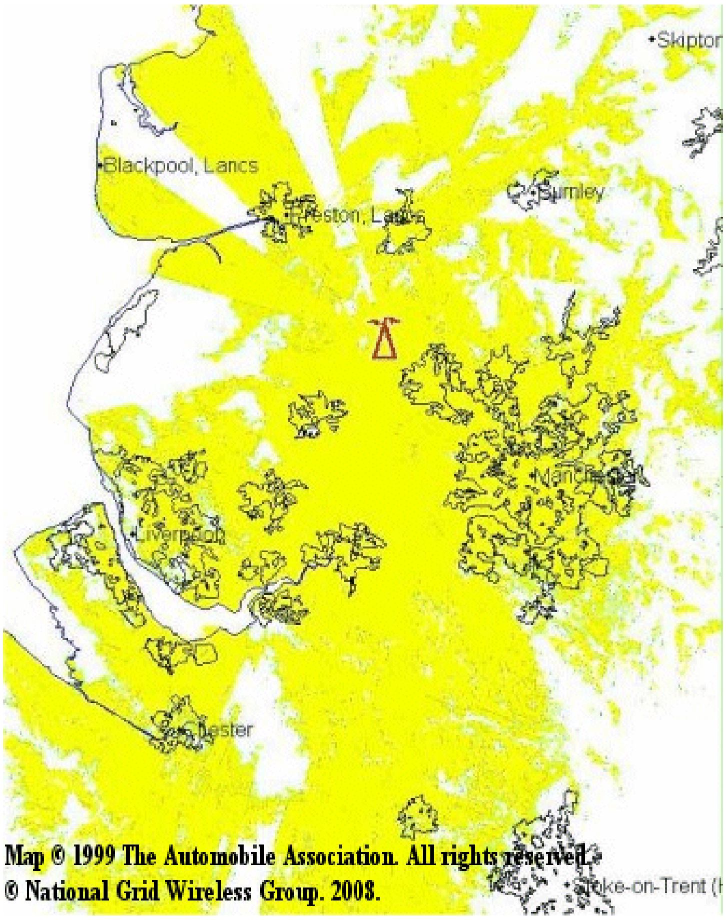
5.7 These lots are the basic building blocks of spectrum that can be awarded, which can be used individually to cover a specific city, town or community; or they can be aggregated in a number of combinations to cover regions, nations or the UK.

5.8 The list of potential lots is shown in Table 6.1. We set out examples of the potential coverage offered by individual and aggregated lots in the following paragraphs. All coverage predictions are based on a certain set of assumptions concerning the extent of protection of existing DTT multiplexes that we term the median method (unless otherwise stated), as is described later in this section.(see paragraphs 5.21-5.30)

Individual lots

5.9 An example of a large lot is channel 56 from the Winter Hill transmission site. Figure 5.1 shows that it potentially covers much of North-West England including Greater Manchester and Liverpool, with a total population of more than 2 million households. The coloured area shows the predicted coverage.

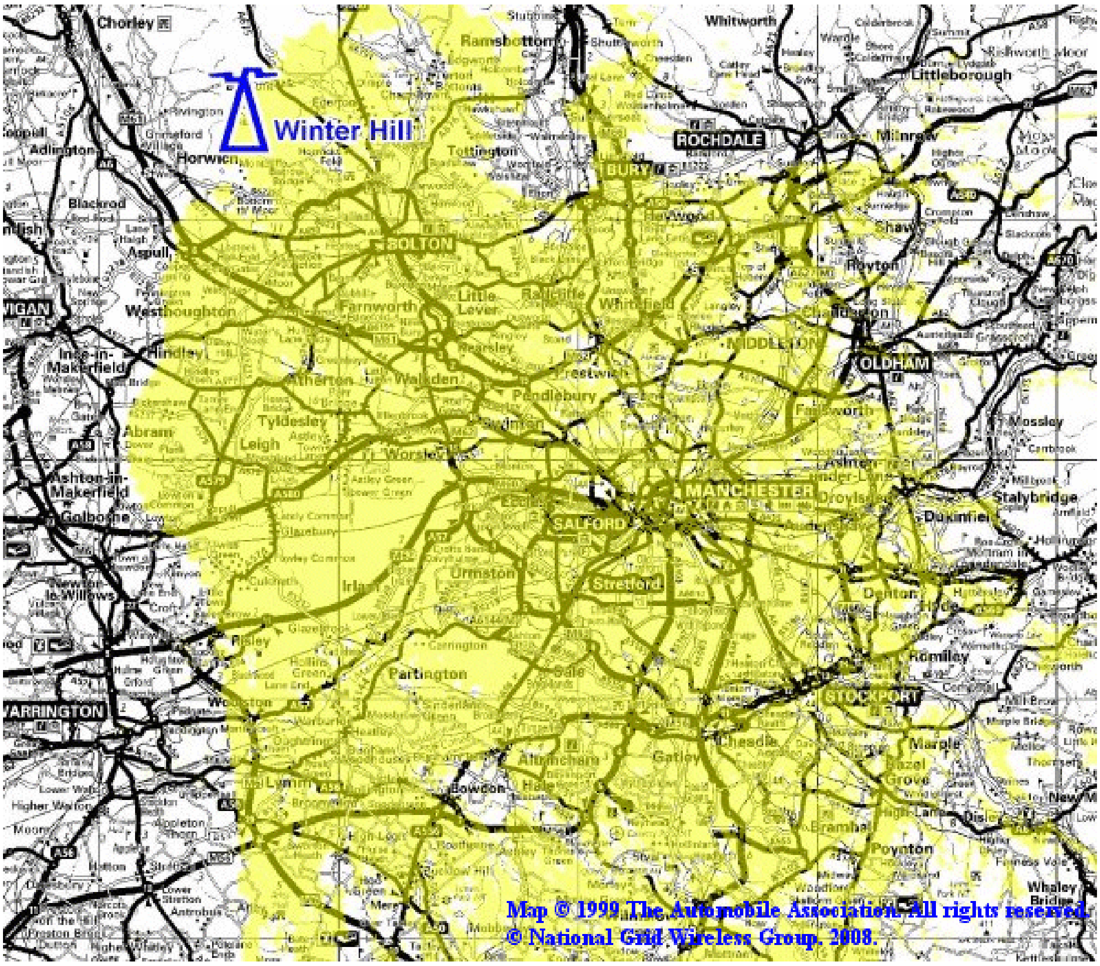
Figure 5.1 Potential coverage of large lot from Winter Hill



Source: NGW
Note: Modulation - 64QAM

5.10 An example of a medium lot is channel 57 from the same Winter Hill transmission site. Figure 5.2 shows that it potentially provides targeted, directional coverage of Manchester itself. The total population covered is smaller at about 800,000 households but is still potentially commercially significant.

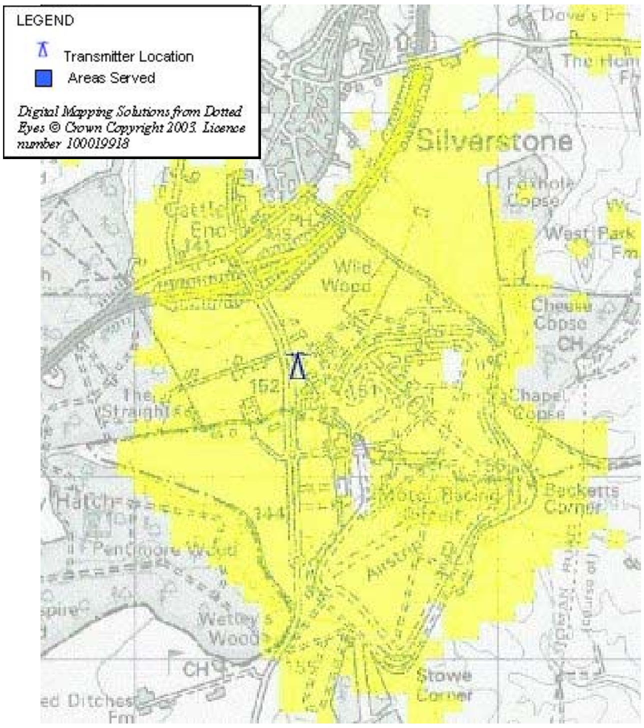
Figure 5.2 Potential coverage of medium lot from Winter Hill



Source: NGW
Note: Modulation - QPSK

5.11 An example of a small lot is channel 65 from Silverstone. Figure 5.3 shows that it potentially provides very localised coverage of Silverstone Racing Circuit. This lot could be used to provide a TV service to spectators within the racing circuit covering, for example, the F1 British Grand Prix.

Figure 5.3 Potential Coverage of Small Lot from Silverstone



Source: NGW
Note 1: The Silverstone prediction was done using the current planning method for RTSLs, not the median method.
Note 2: Modulation - 16QAM

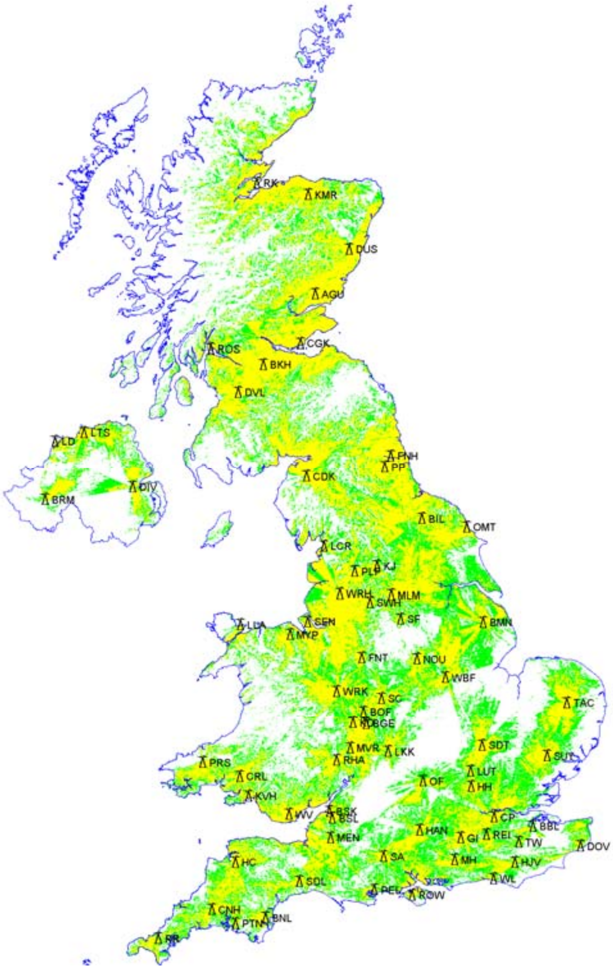
5.12 Individual lots offer various coverage possibilities ranging from a region to a town, city, small community, or event location. For those who want access to spectrum to serve smaller communities and events, which require more localised coverage or limited duration, there is a balance to be struck between bidding in an auction for what we would refer to as small geographical lots, and accessing the spectrum through negotiating with an operator that has or will have rights to relevant spectrum (such as the operator of an existing DTT multiplex, a new multiplex operator or the band manager). Depending on demand (which we consider later, see section 7), auctions may not represent the most appropriate means for securing optimal use of relevant spectrum. In addition, the costs of holding a potentially large number of auctions for relatively small lots where there may not be substantial competitive demand may not be proportionate. We need to consider relative potential benefits of maximising the opportunity to make spectrum available to the market via auction relative to the costs of putting lots to market in this way, within the context of our statutory duties.

Aggregation of lots

5.13 Individual lots can also be aggregated in a multitude of combinations. For example, Figure 5.4 shows the potential coverage provided by aggregating 71 large and medium lots together. This aggregation of lots would cover about 53 per cent of the UK population (14 million households) using 64QAM modulation with capacity for eight to nine video streams (or about 76 per cent using QPSK modulation with capacity for three video streams).

Figure 5.4 Potential coverage of 71 aggregated lots in the UK

(64QAM = Yellow, QPSK= Green)



Source: NGW

5.14 Of the 71 lots, 4 are in Northern Ireland, 8 are in Scotland, 6 are in Wales and 53 are in England. Table 5.1 shows the potential coverage offered by aggregation of the relevant lots in each nation.

Table 5.1 Potential coverage of aggregated lots in the nations

Nation	Number of aggregated lots	Coverage (64QAM)
England	53	51 per cent
Northern Ireland	4	32 per cent
Scotland	8	79 per cent
Wales	6	52 per cent

Source: Ofcom

5.15 Many other combinations of lots are possible. For example, lots could be aggregated to provide coverage of a particular nation or region. Coverage need not be contiguous either; several city based lots could perhaps be aggregated to form a city TV network.

Question 6. What levels of coverage and aggregation are of interest to you?

Potential optimisation of interleaved spectrum

5.16 The main users of the interleaved spectrum are the existing DTT multiplexes. However there will still be gaps, or white space, in the interleaved spectrum after DSO which could be used for additional services. So far, all the work to identify potential lots for new services has assumed that the DSO frequency plan for the existing DTT multiplexes is fixed. But it is possible with a small number of adjustments to the technical details of the DSO frequency plan to release more white space, whilst still meeting the DSO coverage targets. Ofcom commissioned National Grid Wireless Ltd (NGW) and Arqiva Ltd (Arqiva) to look at potential optimisation of interleaved spectrum in Scotland and Northern Ireland respectively, as in these areas, there seemed to be some scope to do this.

5.17 NGW's study[21] indicates that five fewer channels (30, 48, 51, 52, 56) could be used for the existing DTT multiplexes in Scotland by revising the DSO plan for one main transmission site (Rumster Forest) and nine relays. If these five channels were then used for two additional new DTT multiplexes, coverage (assuming 64QAM) could be as shown in Table 5.2. Note that these coverage predictions are just examples of what could be done with the optimised spectrum.

Table 5.2 Potential coverage from optimisation of interleaved spectrum in Scotland

Multiplex	Coverage of Scotland (households)	Notes
First additional	84 per cent	Using 15 transmission sites
Second additional	52 per cent	Using Black Hill and Craigkelly only (i.e. covers Glasgow and Edinburgh)

Source: Ofcom

5.18 Comparing the coverage figures in Tables 5.1 and 5.2, we can see that potential Scotland coverage is higher if the interleaved spectrum can be optimised than through straightforward aggregation of Scottish lots. We are discussing with the operators of the existing DTT multiplexes the feasibility consequences of making any technical adjustments to the DSO plan. In addition, changes to the DSO plan may also need to be agreed internationally. Further consideration is required on the trade off between the adjustments to the DSO plan and the potential introduction of new services.

5.19 Arqiva carried out a similar optimisation of the interleaved spectrum in Northern Ireland. This study suggests that Northern Ireland coverage could improve to around 85 per cent through optimisation, compared to 32 per cent from the straightforward aggregation of lots (shown in Table 5.2). Again, this would impact upon and require changes to the DSO frequency plan. Any such changes would need to be agreed. We intend to consider this further in taking forward our plans for these awards. There would also need to be agreement between the UK and Ireland for both the new interleaved lots and the changes to the DSO plan for this to happen.

5.20 Having looked at Scotland and Northern Ireland, what are the prospects for Wales and England? Due to its geography and population distribution, it takes almost the same number of transmission sites (and thus frequencies) to cover Wales as it does

[21] *Interleaved Spectrum Planning Study. Final Report*, NGW, 30 November 2007, http://www.ofcom.org.uk/consult/condocs/ddr/statement/NGW1.pdf

to cover Scotland, which has four times the land area and twice the population. There is also the potential for interference with Ireland along the west coast of Wales, and with England in the north, east and south. The interleaved spectrum therefore will be very intensively used after DSO in Wales, with relatively little white space remaining.

5.21 We therefore consider that there is little prospect of a significant improvement in available interleaved spectrum capacity being available in Wales. In addition, DSO preparations for Wales are already far advanced (switchover starts in 2009), with DSO transmission equipment already installed or ordered. Any late amendments to these plans to improve DSO spectrum efficiency are likely to mean additional costs, having to scrap installed equipment, and possibly even the risk of delays to the DSO timetable.

5.22 The availability of interleaved spectrum in England is similar to the situation in Wales, described above. There are too many internal and external interactions for significant additional spectrum efficiency to be realised through changes to the DSO plan. Again, DSO preparations for parts of England are far advanced (Border DSO in 2008/9, Westcountry DSO in 2009, Granada DSO in 2009), and Whitehaven in Copeland has already switched over.

Caveats regarding coverage predictions

5.23 All coverage figures shown in this document have been statistically predicted by a computer model based on the same set of technical criteria and assumptions as those used for DSO DTT planning (the UK Planning Model). These include the assumptions that all households have a good quality in-group aerial at the right height and orientation. The coverage predictions are inherently optimistic because the computer model uses theoretical antenna templates that will not be matched in practice.

5.24 Actual coverage will vary depending on factors such as the real antenna characteristics, the eventual transmitter location, the achievable antenna height, the actual power and the selected channel.

5.25 The coverage predictions also assume transmissions from an antenna located at a certain height on the transmitter mast. It is not known whether there is room on the mast at this or any other height for another multiplex antenna. In practice the tops of masts are typically fully occupied. If a different site and height is used, the predicted coverage will be different.

5.26 In addition, all the analysis assumes that the use of the lots concerned will be exclusively DTT using consistent technology as deployed in the existing DTT multiplexes, and as reflected in the broadcasting industry’s existing planning models. They make no provision for other services or technologies using these lots.

Impact of new DTT services on the existing DTT multiplexes

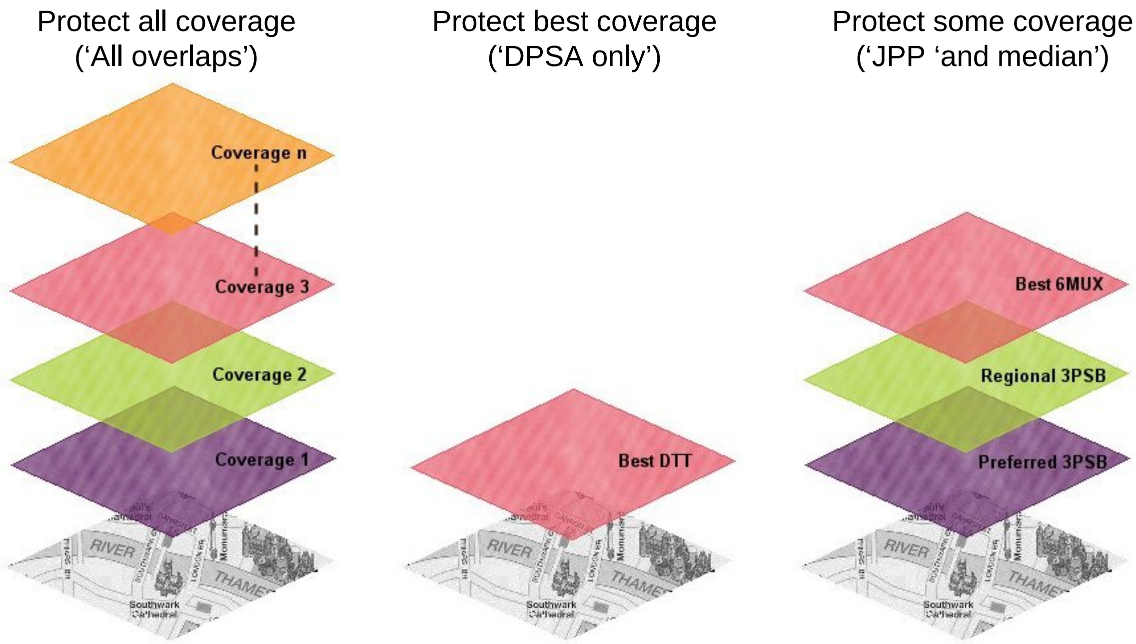
5.27 Introducing new DTT services in the interleaved spectrum could have an impact on the coverage of the existing DTT multiplexes following DSO. We need to strike the appropriate balance between the two.

5.28 The Government wants everybody who currently received the analogue PSB services to be able to receive the PSB channels also on DTT. Ofcom has therefore placed an obligation on the operators of the PSB DTT to match the coverage of the existing analogue terrestrial networks (estimated as being 98.5 per cent of UK households). We consider that it is important that this obligation can be achieved whatever the balance struck between existing and new DTT services. There is no equivalent coverage obligation for commercial DTT multiplexes (at DSO they are expected to be available to around 90 per cent of UK households) but we are equally mindful of the impact that any loss of the planned coverage of these services could have on viewers. We have therefore considered what is the appropriate level of protection that should be provided to existing DTT services in developing our proposals.

Protection options

5.29 In order to meet the planned coverage of DTT from the existing multiplexes after DSO, if just one DTT transmission site covers a particular location, the coverage of that transmission site should be protected. But, in any particular location, some households may, under current plans, have a choice of DTT transmission sites from which to receive existing DTT multiplexes, as there are coverage overlaps. Figure 5.5 illustrates this for a notional location where overlapping coverage from several DTT transmission sites is currently available. A household in that location could be receiving services from any one or more of the transmission sites, assuming the use of a suitable (in group) TV aerial pointing in appropriate direction(s).

Figure 5.5 Overlap coverage protection options



Source: Ofcom

5.30 In such a case of overlapping coverage, the post-DSO protection options we have considered are:

- **All overlaps** - if we protect all existing overlapping coverage from all DTT transmission sites predicted in the post-DSO plans, there will be no impact from any new DTT services using geographic interleaved spectrum on any of the households who may be currently be expected to receive the DTT multiplexes from any one or more of these sites after DSO. But, consequently, there would be fewer lots available for new services to use, affording less coverage, as the existing DTT overlaps in combination use up much of the available interleaved spectrum.

- **DPSA only** - if we protect only the coverage of the 'best' DTT transmission site (referred to as the Digital Preferred Service Area ('DPSA') in NGW's original study for 71 transmission sites), households who are currently expecting to receive services from other overlap transmission sites may no longer have this choice. Some households who would only receive their DTT services from an overlap transmission site may have to realign and/or replace their television aerials to tune to the 'best' site. The 'best' site is taken to mean the transmission site offering at least services from the three multiplexes operated by public service broadcasters ('3PSB coverage') together with the greatest number of the three existing commercial multiplexes in the area concerned. This option would maximise the number and coverage of geographic interleaved lots that would then be available for new DTT services.

- **JPP** - The DSO Joint Planning Project ('JPP'[22]) proposed protecting a total of three overlap coverages with a small fixed increase (0.5dB) in interference. This allows a few new services to be introduced in the interleaved spectrum with little impact on existing DTT coverage. The three protected coverages are:

    - DPSA – refers to the 'best' DTT transmission sites as per the DPSA only option, as described above.

    - Analogue preferred service area ('APSA') – refers to coverage from the transmission sites currently offering the best analogue service to a household. This protects at least part of the coverage of all 1,154 existing analogue transmission sites, thereby moderating the potential disruption to existing TV aerial installations where the DPSA and the APSA do not align. The APSA is determined using a model that takes into account analogue signal strength, availability of Five, and the sequence in which the analogue transmissions were switched on, amongst other factors. The relevance of APSA is that it models where existing aerials are pointed and therefore minimises disruption to existing aerials which is not taken in to account by DPSA.

    - Correct national/regional service – protecting this ensures that all households located in England have a protected 3PSB English service, and similarly for all Welsh, Scottish households. It will also protect the correct ITV/BBC region.

- **Median** – this option protects the DPSA and APSA overlap coverages as with JPP above, but with a higher variable increase (more than 1dB) in interference which allows more new services to be introduced in the interleaved spectrum. The impact on the overlaps in planned DTT coverage is a little higher than the protection offered by the JPP option, while providing a limited reduction in the usability of the geographical interleaved lots to that offered by the DPSA only option.

Analysis of protection options

5.31 The JPP planners do not support the 'All overlaps' option, indicating instead support for the JPP option. We, too, consider that this level of protection does not represent the appropriate balance between existing and new DTT services, and so we do not consider it further.

[22] JPP comprises BBC, Arqiva, NGW, Digital 3&4 Ltd and SDN Ltd, and is chaired by Ofcom. The group was established to provide a consistent approach to planning the introduction of digital terrestrial broadcasting in the UK.

5.32 We have analysed the three remaining protection options (DPSA only, JPP and median) by comparing the:

- Potential impact on the DTT multiplex overlap coverage and associated remedial costs for each option of an aggregated network of ten interleaved geographical lots as an illustrative example.

- Potential coverage and economic value of this illustrative aggregated network of ten lots for each option.

Potential impact on DTT multiplex overlap coverage

5.33 Table 5.3 shows, for each option, the potential impact of an illustrative network of ten interleaved geographical lots on DTT multiplex overlap coverage post-DSO in terms of the number of households who would potentially lose reception of their chosen DTT transmission site, and thus might need to reposition and/or replace their TV aerials to receive from alternative DTT transmission sites. This illustrative network would cover around half of the total UK households which may be served by new DTT services using this spectrum.

Table 5.3 Impact on DTT multiplex overlap coverage

	DPSA Only	Median	JPP[23]
Number of households potentially requiring aerial repositioning or replacement	10,000	5,000	600
Aerial replacement cost (£150 per household)	£1,500k	£750k	£90k

Source: Ofcom

5.34 The aerials of around 10,000 households affected by this notional network of 10 transmission sites may need to be repositioned or replaced under the DPSA option in order to secure the single best set of signals. Under the median option, which offers a higher degree of protection to existing DTT overlap coverage, the number of households needing to reposition aerials would fall to around 5,000. The number of households needing to reposition aerials would fall to fewer than 600 under the JPP option, which offers the most protection to DTT multiplex overlap coverage. On this basis, the DPSA option would require around 5,000 more aerials to be replaced or repositioned relative to the median option. Assuming an aerial replacement cost of £150 per household[24], this would equate to an additional cost of less than £1 million.

5.35 NGW's predictions indicate that many hundreds of thousands of households would in theory be in DTT multiplex overlap coverage areas after DSO for all three options. But predictions cannot tell us how many of these households actually receive signals from overlap DTT multiplexes and hence could be affected, in practice, by new DTT transmissions after DSO. We have used data from the BARB establishment survey to provide an estimate of the number of household which receive more than one ITV

[23] It has not been possible to implement protection of the correct national/regional coverage for the JPP option. Initial indications are that this would further increase protection of existing DTT overlap i.e. even fewer households would need to replace aerials, and consequently coverage of new DTT services would be even lower.

[24] Digital UK FAQs at http://www.digitaluk.co.uk/faqs/how#a_id1448 says "Installation of a standard new roof aerial is likely to cost between £60 and £180. Additional sockets cost around £45. Upgrades to communal aerial systems may result in increased service charges"

region. This number is significantly lower than that predicted by the NGW predictions alone. Annex 5 provides further details.

Potential coverage of new DTT services

5.36 Table 5.4 shows, for each option, the potential coverage of the same aggregated network of ten interleaved geographical lots assuming they are used for new DTT services with 64QAM modulation.

Table 5.4 Potential coverage of aggregated network of ten lots

	DPSA Only	Median	JPP[23]
Potential coverage of aggregated network of ten interleaved lots in households	7.3m	7.0m	5.0m

Source: Ofcom

5.37 The table indicates that the JPP option, which offers more rigorous protection of the possible level of choice within overlap areas for DTT services, would mean that significantly fewer households would benefit from new services that might be provided through the interleaved spectrum. The value of these new services is subject to considerable uncertainty. It is not clear for example which service might be provided, although there is a high likelihood it will be some form of broadcasting service.

5.38 An illustration of the relative costs and benefits of each option can in the first instance therefore be gauged by reference to the minimum benefits that new services would bring in order to offset aerial replacement costs. 'For the illustrative network of ten interleaved geographic lots as set out above, this value would be £0.21 per household. That is, were new services to produce a benefit to each household of £0.21, this benefit would be sufficient to offset aerial replacement costs under each of the options. Table 5.5 illustrates this.

Table 5.5 Illustration of the relative costs and benefits of DPSA, median and JPP options

	DPSA Only	Median	JPP[23]
Aerial replacement cost	£1,500k	£750k	£90k
Illustrative benefits of new services, (21p per household)	£1,533k	£1,470k	£1,050k
Net benefit / (cost)	£33k	£720k	£960k

Source: Ofcom

5.39 Consumer research conducted for our 2006 DDR consultation[25] estimated that households would be willing to pay an average price of around £14 per year for 1 local TV channel. Over ten years, assuming a declining valuation per year, this might be represented by an equivalent one off payment of about £55. Our later tranche of consumer research conducted for the DDR statement found that 39 per cent of respondents would be likely to pay a one-off £100 to buy and install a new aerial in order to access eight new standard definition channels.

5.40 These numbers suggest that the overall benefits of new services can be expected to exceed comfortably costs in terms of aerial replacements and so produce overall

[25] http://www.ofcom.org.uk/consult/condocs/ddr/

benefits for households. We could also use these numbers to illustrate the relative benefits of the options against each other and so inform our choice of one option over another.

5.41 Hence, in order purely to illustrate the relative costs and benefits of the different options above, we could assume a one-off benefit per household of new interleaved services at a conservatively low level, say around £40 per household, over the lifetime of the service. Using this illustrative value and the coverage figures above gives an illustrative scale of the consumer benefit of the new services under each of the options for the notional network illustrated above. Table 5.6 illustrates this.

Table 5.6 Illustration of scale of consumer benefit of DPSA, median and JPP options

	DPSA Only	Median	JPP[23]
Aerial replacement cost	£1,500k	£750k	£90k
Illustrative benefits of new services, (£40 per household)	£292m	£280m	£200m
Net benefit of new services / (cost)	£290m	£279m	£200m

Source: Ofcom

5.42 In sum, the JPP option reduces the potential availability of new services by around 2 million households, with an illustrative loss in value to consumers of at least £80 million, while saving only £0.7 million to £1.4 million in aerial replacement costs compared with the median and DPSA options. Although some greater possibility of choice of DTT service exists within overlap areas with this option, it is unlikely to justify the loss in benefits from new services.

5.43 There is much less difference between the DPSA and median options. Relative to the median option, the DPSA option would offer perhaps £12 million of extra benefit from new services and involve less than £1 million additional aerial repositioning costs. However the benefits of both options greatly offset any aerial replacement or repositioning costs.

5.44 Overall, given the likely coverage figures under each option and the relatively small difference in aerial replacement costs between DPSA only and the median options, and the difference in economic value of the DDR geographic interleaved spectrum between these two options, a purely economic assessment would marginally favour the DPSA only option. However we consider that there are other factors that may tip the balance more towards the median option.

Other factors

5.45 As detailed in the original NGW interleaved study, the DPSA only option does not protect about 100 of the existing analogue relays i.e. the DPSA assigned coverage for these relays is zero, even though it is estimated that they are being used by 170,000 households now for analogue TV (i.e. the total APSA coverage of these 100 relays). Also, there are additional relay sites where the DPSA is much less than the APSA. DSO policy is to switch over all 1,154 analogue relays to digital, in part to cater for existing analogue aerials as far as possible, as well as to achieve the 98.5 per cent PSB coverage target. As these relays are required to switch over to digital, we consider it appropriate to protect them from potential interference from new DTT services using geographic interleaved spectrum. This is why the median and JPP options protect the APSA as well.

5.46 The DPSA only option also does not take account of national or regional borders as the DPSA is based on the ‘best’ DTT transmissions regardless of nation or region. For example the DPSA planning would assign 150,000 households in England to the Welsh transmission sites at Moel-y-Parc and Wenvoe. In theory, this means that any transmissions from a transmission site in England that these 150,000 households currently receive could be subject to interference by new DTT services using geographic interleaved spectrum, since the DPSA only protects the overlap transmissions from the transmission site in Wales (and not the transmissions from the transmission site in England). So a proportion of these 150,000 households in England may receive transmissions from a transmission site in Wales with the ‘incorrect’ national/regional programmes (such as local news) due to interference. However the JPP option specifies protection of the correct national and regional service (though it has not been possible to implement this in this example). We consider that there is an argument for additionally protecting at least the correct national service.

Review of protection options

5.47 The JPP option offers stronger protection for DTT choice of services in DTT overlap areas, especially with regards to existing aerials pointing at relays and the correct national or regional service. However, this option also offers lower potential coverage for new DTT services. The economic impacts of losing so much usable interleaved spectrum could be relatively significant. The analysis suggests that the JPP option is very unlikely to yield the optimal use of the spectrum concerned.

5.48 The DPSA only option maximises the economic value and potential coverage of new DTT services relative to the alternatives examined. But, as detailed in the NGW study which we published with the DDR statement, it does not protect 100 existing analogue relays, or the correct national or regional service. It also has the largest potential impact on DTT overlap coverage, with about 10,000 households in the illustrative network of ten sites that we analysed (all of which would be in overlap areas) potentially requiring replacement or repositioning of their TV aerials,

5.49 The median option offers significantly more potential coverage for new DTT services relative to the JPP option, although that access to new DTT services would still be materially reduced by around 300,000 households in our example of a ten site network. Equally this option has less of an impact on DTT overlap coverage relative to the DPSA only option.

5.50 The choice between the DPSA only and median options is finely balanced. On the one hand, under the DPSA only option, many more households may receive new services than would be required to replace aerials, such that the attendant financial benefits may significantly outweigh the extra aerial replacement costs.

5.51 On the other hand, the median option would afford a degree of protection to all 1,100 or so transmission sites that will be switched over to digital, including the 100 or so relays that are not protected by the DPSA option. Protection of the correct national service could also be added. The value of these benefits is more difficult to quantify and therefore set against the value of new services offered via the interleaved spectrum. However, we consider they are important, and could be greater than the value of access to new services to more households that would be offered by the DPSA only option. On balance, we favour the median option.

5.52 These proposals will also apply to other uses of interleaved spectrum. In particular the adoption of the median option on a UK-wide basis is likely, in some cases, to increase the availability of spectrum for PMSE users in areas of overlapping coverage. Further details of this will be published in the consultation on the band manager award, later in the summer.

Conclusions

5.53 The studies we commissioned have shown that geographic interleaved spectrum can be used to provide new DTT services with coverage ranging from single communities to (via aggregation) regions, nations and the much of the UK.

5.54 We considered various options for the protection of existing DTT multiplexes from new DTT services using geographic interleaved spectrum. We consider that the median option offers the best balance between maximising the economic value of the geographic interleaved spectrum and minimising the potential disruption to overlap coverage of the existing DTT services, and therefore propose this form the basis of the planning for new services.

Question 7. Do you agree that the median option offers an acceptable balance between protecting reception of DTT services and maximising new DTT services using geographic interleaved lots?

Section 6

Spectrum packaging

Introduction and summary

6.1 In this section we consider the lots to be awarded and the timing of the awards. We

- recap what we said in the DDR statement;
- describe the location and channel for each lot that we might award;
- propose a candidate list of sites where lots may be available;
- discuss the sequencing and timing of the awards;
- discuss the need for evidence of demand for the lots to be auctioned; and
- describe how we propose to assess evidence of demand arising from expressions of interest.

What we said in the DDR statement

6.2 Our main conclusions on these awards were:

- We would award one or two frequency channels at a number of transmission sites, suitable but not reserved for local TV.
- The channels would be 'in group'[26] for a given coverage area from a specific transmission site, able to permit broadcasts at sufficient power to be received by most households in that area.
- We would package the spectrum in geographic lots, based on main transmission sites serving major towns and cities and in areas where local TV operators were already licensed to provide an analogue service. We gave an indicative list of 25 possible locations across the UK where we expected that interest would justify offering such lots. We were willing to consider other locations if there was persuasive evidence of demand. At our January 2008 stakeholder meeting for local TV interests we invited feedback on this point (see paragraph 6.10).
- The geographic interleaved spectrum would be awarded by auction to the highest bidder.
- We would aim to conduct the awards in each ITV region at least a year before DSO in that region, where possible, to give successful bidders time to develop their operations before spectrum became available for use.
- The first lots would be awarded in late 2008 for those transmission sites (Caldbeck, Winter Hill and Wenvoe) which would provide coverage for areas where existing RTSL operators needed, prior to DSO, sufficient clarity about their options for future spectrum access.

[26] 'In group' means that particular channels will be within the antenna frequency range of the post-DSO DTT frequency channels from transmission sites at particular locations.

- The remaining geographic interleaved spectrum would be awarded later.
- Awarding geographic interleaved spectrum sequentially might make it difficult to acquire a number of lots (create an aggregation risk) for an operator that wished to offer services in more than one geographic area at once. We would consider this when deciding whether to award the remaining channels sequentially or simultaneously.

Assessing where and what frequency channels we should auction

6.3 We set out here our approach to assessing which channels and types of coverage should be offered for award, in which locations, and how many channels at each location. We do this with reference to the types of lots that could be available for sale and the potential demand for spectrum. We discuss later our proposed approach to the sequencing and timing of awards (paragraphs 6.26ff).

Types of lots

6.4 As we described in section 5, the availability and coverage of interleaved spectrum will vary by transmission site and channel. A number of sites will have channels available that provide good, all round geographical coverage, and are likely to be suitable for aggregation with others or on a standalone regional basis. We refer to these as ‘large’ lots. Some channels will provide more targeted or directional coverage, so offering the possibility of smaller city or town coverage but still potentially commercially significant coverage of many households. We refer to these as ‘medium’ lots. Other sites may offer channels with smaller coverage, particularly where these happen to be relays rather than main transmission sites. Transmission from such sites might be suitable for local, event or community broadcasting. We refer to these as ‘small’ lots. Many sites will offer a number of channels, meaning that some combination of large, medium and small lots may be available at any one site.

6.5 The number of lots that is potentially available for auction and the relative mix of these in terms of ‘large’, ‘medium’ and ‘small’ lots will be determined by demand and technical considerations and constraints.

Alternative ways to access the interleaved spectrum

6.6 There are a number of options for obtaining rights to using spectrum, besides acquiring them through a spectrum award. It would be possible to access spectrum through bilateral negotiation with the band manager[27]. It would also be possible to acquire rights through spectrum trading with licensees who hold spectrum attractive to others. An existing or new multiplex operator would also be able to provide capacity to broadcasters. In deciding how best to obtain rights to use spectrum interested parties will need to compare the costs and benefits of the alternatives. Overall, we consider that the relative potential benefits of maximising the opportunity to make lots available to the market via auction need to weighed against the costs of putting lots to market and the costs involved in bidding for such lots. If there is little demand for spectrum in a particular locality (so that it has a low opportunity cost) or the lot is only required for a short period of time for a specific event, the auction process may prove inefficient and unnecessary, particularly if access to sufficient suitable interleaved spectrum could be acquired through other means.

[27] We intend to publish a separate consultation in relation to the spectrum to be awarded to a band manager later in the summer.

6.7 In general we consider that what we refer to as ‘small’ lots would not be included in the spectrum awards. We describe below (paragraphs 6.51ff) the process we propose for assessing demand for particular transmission sites for inclusion in the award. In that process it will be open to interested parties to make a case for including particular ‘small’ lots in the award.

Candidate locations and channels for award

6.8 In the DDR statement we set out an indicative list of 25 locations and said that we anticipated auctioning lots for these locations. The list took into account the level of population coverage that might be required for broadcasting and areas where there were existing RTSLs. We said we would consider adding further locations if there was evidence of demand. In aggregate, these 25 locations could, depending on the compression technology adopted, provide DTT broadcasting coverage of around half or more of UK households. Most of the lots at these sites would be ‘large’ lots.

6.9 NGW work, also published in December 2007[28], provided coverage data for a set of frequency channels at 71 transmission sites (including the 25 indicative locations). This coverage data was based on the DPSA definition of protection of DTT services; changes to the protection of DTT will therefore, as explained in section 5, alter coverage.

6.10 We held a stakeholder event for parties specifically interested in local TV on 14 January 2008, where we invited participants to indicate if and where they might be interested in acquiring lots. This revealed interest in providing broadcasting services in 18 areas. Some of these were linked to a particular location (ten at locations included in NGW’s work, eight elsewhere). Others were interested in providing broadcasting services over a wider area and so implied an interest in aggregating ’large’ lots.

6.11 The Crown Dependencies are interested in lots being made available either through this award (Guernsey and Jersey) or through an independent award (the Isle of Man).

6.12 On the basis of the above, we have compiled a list of candidate transmission sites, each of which could form the basis for one or more lots. In Table 6.1 these are listed as follows:

- 25 sites listed in the DDR statement (including existing RTSLs), (rows 1 to 25);
- the 46 sites remaining of the 71 sites identified in the NGW study (rows 26 to 71);
- eight transmitter sites, additional to the list of 71, identified following the January 2007 stakeholder event, (rows 72 to 79); and
- two sites in respect of Crown Dependencies (Guernsey and Jersey, and Isle of Man), (rows 80 and 81).

[28] *Interleaved Spectrum Planning Study Final Report*, NGW, 30 November 2007, http://www.ofcom.org.uk/consult/condocs/ddr/statement/NGW1.pdf

Table 6.1 Indicative list of transmission sites and frequency channels

No.	Site	Indicative channels	Relevant area	No.	Site	Indicative channels	Relevant area
1	Caldbeck	21 and 48	Carlisle	42	Bristol Kings Weston	30	Bristol relay
2	Winter Hill	57 56 and 60	Manchester/Liverpool.	43	Rosemarkie	52	Inverness
3	Wenvoe	30 and 51[29]	Cardiff	44	Rosneath VP	48	Greenock
4	Mendip	55 and 59[29]	Glastonbury/Somerset	45	Knockmore	56	Elgin
5	Craigkelly	52 and 30	Edinburgh	46	Angus	48	Dundee
6	Black Hill	51 and 48	Glasgow	47	Durris	30	Aberdeen
7	Oxford	49 and 29	Oxford	48	Darvel	30	Ayr
8	Waltham	55 and 59	Leicester	49	Luton	45	Luton
9	Belmont	21 and 23	Grimsby/E. Yorkshire	50	Olivers Mount	56	Scarborough
10	The Wrekin	48 and 29	Shrewsbury/Telford	51	Sheffield	26	Sheffield
11	Ridge Hill	30 and 23	Ross-on-Wye/Hereford	52	Nottingham	62	Nottingham
12	Emley Moor	45 and 56	Leeds	53	Kidderminster	56	Kidderminster
13	Sutton Coldfield	51 and 29	Birmingham	54	Lark Stoke	48	Stratford upon Avon
14	Sandy Heath	49 and 23	Bedfordshire	55	Brierley Hill	56	Greater Birmingham relay
15	Sudbury	49 and 57	Suffolk	56	Keighley	56	Keighley
16	Tacolneston	57 and 49	Norwich	57	Malvern	51	Malvern
17	Hannington	43 and 49	Basingstoke	58	Bromsgrove	29	Bromsgrove
18	Rowridge	29 and 30	Southampton/Portsmouth	59	Fenton	29	Stoke on Trent
19	Crystal Palace	29 and 42	London	60	Poole	50	Poole
20	Heathfield	54 and 45	East Sussex	61	Guildford	54	Guildford
21	Dover	57 and 49	Dover	62	Hemel Hempstead	49	Hemel Hempstead
22	Bilsdale	24 and 21	Middlesbrough	63	Midhurst	46	West Sussex
23	Pontop Pike	56 and 51	Newcastle	64	Salisbury	49	Salisbury
24	Londonderry	22 and 52	Londonderry NI	65	Reigate	51	Reigate
25	Divis	30 and 56	Belfast NI	66	Whitehawk Hill	54	Brighton
				67	Tunbridge Wells	51	Tunbridge Wells
26	Beacon Hill	49	Torquay	68	Bluebell Hill	56	Mid Kent
27	Stockland Hill	30	Honiton/Exeter	69	Limavady	56	North West of NI
28	Huntshaw Cross	51	Barnstaple	70	Brougher Mountain	30	Omagh NI
29	Plympton	49	Plymouth	71	Fenham	30	Newcastle relay
30	Redruth	55	Cornwall				
31	Caradon Hill	30	Devon	72	Selkirk	56	Borders
32	Presely	30	South East	73	Bressay	30	Shetland Islands
33	Carmel	52	South East	74	Keelylang Hill	48	Orkney
34	Llanddona	51	Anglesey	75	Rumster Forest	52	Wick/Thurso
35	Lancaster	30	Lancaster	76	Eitshal	30	Isle of Lewis
36	Saddleworth	43	Saddleworth	77	Tay Bridge	51	Dundee relay
37	Storeton	30	Birkenhead/Liverpool	78	Perth	30	Perth
38	Pendle Forest	30	Burnley	79	Balgownie	51	Aberdeen relay
39	Moel y Parc	30	North East				
40	Kilvey Hill	30	Swansea	80	Isle of Man	51	Douglas Isle of Man
41	Bristol Ilchester Crescent	51	Bristol relay	81	Jersey and Guernsey	48	Jersey and Guernsey

[29] Some frequencies are currently expected to remain in use for DTT services for a temporary period after DSO at certain transmitters. This is anticipated to involve channels 30 and 51at Wenvoe and channel 59 at Mendip. It is anticipated that these frequencies would be available from May 2011. A temporary frequency will be made available capable of providing coverage equivalent to that achieved by the existing Cardiff RTSL in analogue form.

Deciding which candidate locations and channels to include in the award

6.13 Our approach to spectrum packaging is to reflect potential demand. We will award spectrum where there is a reasonable expectation of demand and in a way that reflects as far as possible the likely geographic pattern of demand. The consideration of putting any set of lots to market by auction will need to take into account the optimal use of the spectrum, be consistent with our statutory duties and proportionate, including a consideration of all the costs of conducting and participating in auctions.

6.14 As noted in paragraphs 4.20 to 4.37, we undertook further stakeholder research in order to understand potential uses for geographic interleaved spectrum. This pointed to potential demand for this spectrum for broadcasting applications both at a local level and for aggregating lots in order to provide regional, national or sub-UK services.

6.15 The indicative list of 25 sites in the DDR statement would be suitable for providing services at a number of locations or over a wide area, as well as for local coverage. We are proposing to offer mainly large lots at these sites in a combined award that would allow aggregation of lots. We are prepared to add to the list if, in response to this consultation, a persuasive case is made that further sites would be suitable for aggregation. The award of spectrum at sites on the list as it stands is confirmed and we would only consider removing sites if responses to this consultation demonstrate convincingly that there is unlikely to be demand for a particular site.

6.16 As we said in the DDR statement, we will award spectrum first at those transmission sites that provide coverage for areas where existing RTSL operators need, prior to DSO, sufficient clarity about their options for future spectrum access. These are Caldbeck, Winter Hill and Wenvoe.

6.17 It is generally possible to offer two or more channels at any one site. Doing so could allow more than one type of local application (e.g. broadcasting and non-broadcasting). At Winter Hill, for example, we have also identified channels that could allow Manchester and Liverpool to be covered separately. We consider that there may be sufficient demand for use of second channels at the 25 sites to offer them for award - as well as a channel at each of the other 56 sites on the table above.

6.18 The full list of 81 sites in the table above could be included in the award. However, we consider that demand may be less certain for sites not included in the list of 25 in the DDR statement. It may be the case, for example, that funding possibilities for more local applications only become clearer where they are closer to the possibility of being launched, as determined by the DSO timetable. It might also be the case that interest emerges following the roll out of other successful new broadcasters, or non-broadcasting applications (such as local WiMAX) as a result of future developments during the DSO period.

6.19 For these reasons we are proposing to include sites for award on the basis of evidence of demand, demonstrated by expressions of interest. As mentioned above, the need for expressions of interest will not apply to the early award of Caldbeck, Winter Hill and Wenvoe or to the award of first channels at the 25 indicative sites. We set out our approach to expressions of interest in paragraphs 6.50ff. Some of the expressions of interest received to date have not been fully developed and we may seek further information from those who submitted them.

Further work on coverage of the proposed lots

6.20 NGW's coverage predictions for the 71 transmission sites mentioned in paragraph 6.9 above, were done on the basis of the DPSA definition of coverage. In section 5, we explain that we have considered different options for protecting existing DTT services and propose the median approach. We have asked NGW to do further analysis of predicted coverage using the median approach for the 81 sites in the table above, which we will publish in due course.

6.21 NGW will consider each channel and location in isolation, such that the coverage predictions for example do not take into account effects and interactions from any possible new neighbouring channel usage. It may be necessary, when considering which lots are offered to market, to amend or reconsider the channel offered from a particular transmission site in order to optimise possible outcomes.

Sequencing and timing of the awards

6.22 A fundamental question in auction design, where we have a number of channels or lots to award, is whether they should be awarded in a series of sequential awards or in one award, with the spectrum lots awarded simultaneously.

6.23 Simultaneous awards generally work more efficiently where lots are close substitutes and/or complements. They can be designed with a number of rounds that allow bidders to switch between lots from round to round as prices change, so allowing substitution between lots. They can also allow bidders to bid for a number of lots in the same round, thus potentially easing the aggregation risk where lots are complements. The extent to which risks are ameliorated will depend on the auction design chosen.

6.24 However, sequential awards are not always unattractive. They are likely to work successfully where the spectrum lots on offer are not so closely related, such that they are not strong substitutes or complements for each other, e.g. the geographic coverage of lots might limit the extent of any common business case, or other constraints (such as incumbent use) might mean that lots are available at times for new uses. Sequential awards can also be appropriate where there is a hierarchy of demand between lots across all bidders, e.g. where one lot is an inferior substitute for the other, or where demand for one lot from some bidders is dependent on buying another but not vice versa. In these cases, if the more important lot is auctioned first, substitution and aggregation risk should be modest.

6.25 Sequential approaches can also have significant advantages by avoiding excessive complexity and bringing spectrum to market more quickly. This can have significant advantages for citizens and consumers by encouraging entry and helping to get spectrum into use. They may also be simpler and so facilitate participation and reduce administrative costs for all parties.

Our approach to sequencing and timing of the awards

6.26 As set out in section 4 there are a number of potential uses for the geographic interleaved spectrum, and these might vary according to location and the size of coverage required for a particular application and the coverage available from frequencies at particular locations.

6.27 In determining whether to hold a series of awards or a single award we have considered the interests of two broad sets of users:

- Users wanting to provide services in a particular defined locality.

  These users are likely to want ‘medium’ or ‘small’ spectrum lots. They may like us to award the relevant frequency some time ahead of DSO in order to allow them to develop their operational and associated business plans. But they may not want the timing to be so far ahead that they are unable to develop credible business plans that would allow them to put in place any financial backing they might need. Without adequate financial guarantees they might be unwilling to commit themselves to acquiring spectrum in an early award.

  These considerations are particularly likely to be applicable in the case of smaller, non-commercial or community local TV. These may be reliant on some form of public funding and uncertainty concerning this is likely to be greater where the period between the need to obtain spectrum and its possibility for use as determined by DSO is greater.

  Given that we are committed to maximising possibilities for all interested parties to have an opportunity to purchase spectrum through auction, these considerations would – all other things being equal - point us to holding a series of awards such that relevant lots were auctioned closer to their corresponding dates for DSO.

- Users wanting to provide services in a number of localities or on a regional or national or sub-UK basis.

  These users are likely to want mainly ‘large’ lots. A key consideration for them is likely to be the desirability of obtaining, in one award, all the spectrum they need to create the geographic coverage they require. They are likely to want to resolve any uncertainty over obtaining necessary spectrum sooner rather than later. For example a bidder interested in a regional or sub-UK multiplex or multiplex covering Scotland might wish to bid for all the lots that are needed for such services at the same time. The success of their business plans might rely on providing services in all or most of the locations they have identified.

  A sequence of awards over time would present the risk that they would obtain only some of the spectrum lots they need. We referred in the DDR statement to this ‘aggregation risk’ as being a particular concern when the values of different geographic lots are potentially interdependent with each other.

6.28 These considerations point in different directions for the sequencing and timing of the spectrum awards. The aggregation risk points to a simultaneous single award, at least of ‘large’ spectrum lots – i.e. those lots most suited to being aggregated. Given that bidders interested in obtaining large lots are likely to want to resolve any uncertainty over obtaining them earlier rather than later, and in line with our target of awarding spectrum with the minimum delay possible.

6.29 On the other hand, interest in more local use and the particular uncertainties around funding for smaller operations point to some form of sequential award process that appropriately takes into account these issues without giving such operators undue advantage.

6.30 One approach to uncertainties or difficulties regarding funding might be to allow bidders to make phased payments rather than a one off payment. We discussed this in the DDR statement. Phased payments retain a clear auction process and a good degree of competition between different uses. But there are significant drawbacks in this approach in that it introduces a credit risk for Ofcom. It could also represent an implicit subsidy to the cost of capital. Moreover this approach would not address all of the concerns raised by small operators, which include difficulties in securing funding far in advance of DSO.

6.31 An alternative approach would be to hold a sequential series of awards of medium (and possibly some small) spectrum lots in step with DSO. We would conduct these awards, where possible, at least a year before DSO. This would give successful bidders time both to secure financing and to develop their operations before spectrum becomes available for use. It would also go some way to meeting concerns from small operators.

6.32 In deciding the timing of award we need to bear in mind the position of some existing RTSLs who cannot transmit in analogue after DSO in their region but might be unable to acquire, sufficiently in advance of DSO, a frequency channel enabling digital transmission. The affected operators are Carlisle TV (the Caldbeck transmission site switches between April and June 2009), Channel M in Manchester (the Winter Hill transmission site switches between October and December 2009) and Capital TV in Cardiff (the Wenvoe transmission site switches between January and March 2010).

Options for sequencing and timing of awards

6.33 We have identified three basic options for the sequencing and timing of the awards:

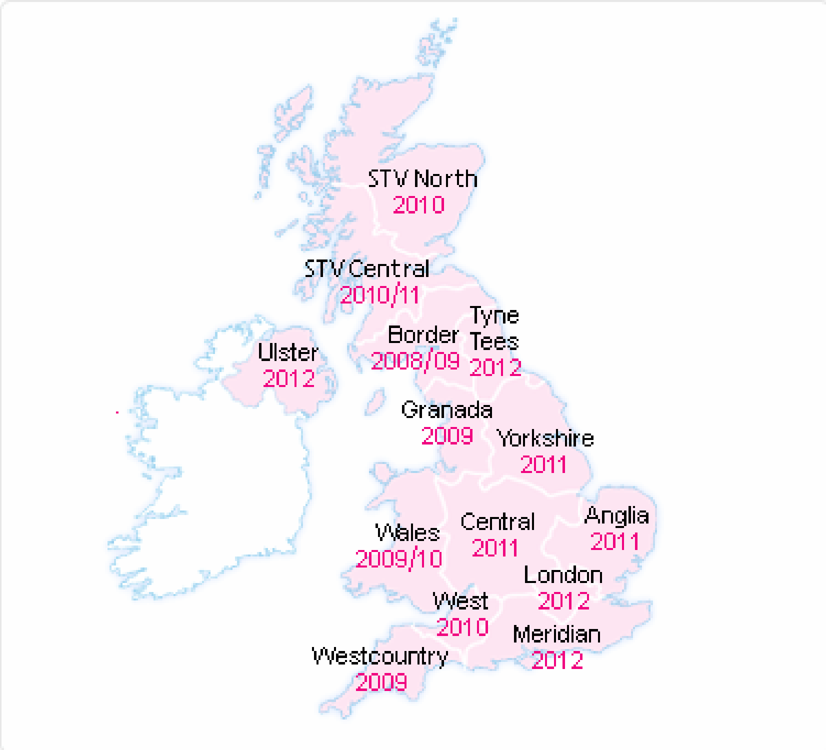
Option 1 a single combined award of all available lots as soon as practicable;

Option 2 an award of medium lots for Caldbeck, Winter Hill and Wenvoe in late 2008 or early 2009, followed by a single combined award of all remaining lots (large, medium and small) as soon as practicable; and

Option 3 a phased approach: an award of medium lots for Caldbeck, Winter Hill and Wenvoe in late 2008 or early 2009; a single combined award as early as practicable of all large lots; and, awards linked to the DSO timetable for all remaining lots.

6.34 Figure 6.1 summarises the timetable for DSO by region. A refined list by location is available at Annex 6.

Figure 6.1 DSO timetable by region



Source: Digital UK

6.35 Option 1 would address the aggregation risk. It would also give all three existing RTSL operators faced with early DSO the opportunity to obtain the spectrum they need in good time - but only if we could hold the award before early 2009. Given the preparation we and stakeholders need for such an award there is a significant risk that this would not be possible.

6.36 A single combined award later in 2009 might be more realistic but would not give much or any time for those particular RTSL operators to obtain geographic interleaved spectrum in advance of DSO. This issue could in principle be addressed by extending the duration of the RTSLs and allowing digital broadcasting until the relevant lots are awarded. But this approach could also extend uncertainty for the RTSL operators concerning their eventual acquisition or otherwise of lots in the 2009 award.

6.37 Furthermore, the timing of an award in late 2009 would perhaps be too early for those with an interest only in medium or small lots in areas where DSO is planned for significantly later.

6.38 Option 2, a variant of the first, would explicitly meets the needs of existing RTSL operators faced with early DSO. It also substantially addresses the aggregation risk by awarding all remaining spectrum at the same time, though not eliminating it in respect of the first three locations. But it shares with option 1 the problems arising from awarding spectrum that might be used by smaller organisations two or three years in advance of DSO in some areas.

6.39 It follows that neither of the first two options in our view meets satisfactorily all the points that we need to address in the sequence and timing of awards.

6.40 Option 3 – a phased approach – would be a more appropriate response to the needs both of RTSLs faced with early DSO (initial phase: early award for Caldbeck, Winter Hill and Wenvoe in 2008 or early 2009) and of those potential entrants with local interests who would, prefer an award no more than a year or so before DSO, by structuring some awards around the DSO timetable after 2009. It also substantially addresses the aggregation risk, by awarding through a simultaneous 'combined' auction large lots that are likely to appeal to those operators interested in wider geographic coverage at regional or national or sub-UK levels. This simultaneous award would release to the market a substantial amount of spectrum that could bring benefits to operators and their customers shortly after the award of spectrum suitable for national multiplexes in the cleared DDR auction.

6.41 This approach also provides equal opportunity for a disparate set of bidders to participate in auction. Bidders interested in purchasing 'large' lots suitable for aggregation will have the opportunity to compete for these on an equal footing in a combined award, with the outcome determined by those who value these lots most. The phased auctions will also be open to all and particularly provide an opportunity for bidders interested in 'medium' or 'small' lots to participate. Moreover the phased approach provides an opportunity for smaller operators to arrange funding (which may include public sector sources) closer to the roll out of services.

6.42 Option 3 could in principle limit substitution possibilities between large and medium lots. For example, a bidder interested in a particular location that is being offered as a lot in both the combined and phased auctions[30] will need to decide whether to participate in the former auction or to wait until the latter. Either strategy carries risks that this bidder will either not obtain the desired lot or that the bidder will obtain a lot but will have paid more than might have done in the other auction. However, we consider that only a minority of bidders are likely to fall into this category and that any inefficiency would be alleviated at least in part by secondary trading. Overall we consider that the advantages of option 3 significantly outweigh any disadvantages.

Proposals for timing and awards

6.43 We therefore propose to sequence and time a series of awards according to option 3, subject to the availability of suitable frequencies in all the affected areas and relevant expressions of interest.

6.44 The precise timing for the awards under option 3 will need to be refined. However, subject to feedback on issues raised in this and the parallel DDR consultations, and any relevant EU developments (see paragraphs 3.32-3.41), we would presently envisage a series of awards:

- In the initial phase we would award medium lots in the areas where DSO is before spring 2010 and where there are existing RTSLs (these three sites are Caldbeck, Winter Hill and Wenvoe, sites 1-3 in Table 6.1). This stage would occur in late 2008 or early 2009.

- The combined award would take place in 2009 and would award the large lots most suitable for aggregation in all areas in a simultaneous process (likely to include sites from the range in 1-25 in Table 6.1).

- The final phase would then involve the remaining awards of medium and small lots in those areas not already included in the initial phase, where these are

[30] Lots in this case being for the same transmitter but differentiated by frequency.

supported by an appropriate expression of interest (this could include any of the sites listed in Table 6.1). We will not restrict who may apply for each lot to those who have submitted expressions of interest. We consider that it is more practicable to award final phase lots in batches. Hence channels in those localities where DSO occurs in 2011 would be the subject of an award in early 2010, with award in early 2011 in respect of DSO in 2012. This approach would avoid having to hold a large number of separate awards.

Question 8. Do you agree with the proposal for a series of awards of spectrum lots - an award of lots for Caldbeck, Winter Hill and Wenvoe in late 2008 or early 2009, a single award in 2009 of large lots and awards of lots for other locations linked to DSO?

Linkages with the timing of the award of cleared award

6.45 We propose to make the combined award of large lots if possible in 2009. This raises the question of the timing and conduct of this award relative to the cleared award , which is expected to begin in summer 2009. The cleared and the geographic interleaved spectrum may be suitable for similar broadcasting services and bidders may be interested in acquiring both types of spectrum or see one as a partial substitute (or complement) for the other. For example, it is possible that a broadcaster interested in obtaining sub-UK coverage might purchase cleared spectrum. Depending on the channel purchased there could be gaps in coverage because, for example, some locations would have TV aerials ‘out of group’. In that case such a broadcaster might wish to purchase geographic interleaved lots in order to fill these gaps.

6.46 Despite these linkages we do not consider that both cleared and geographic interleaved spectrum should be included in the same simultaneous award. To include the ‘large’ geographic interleaved lots within the cleared award would introduce an additional factor to the specification of lots and would generate a very complex auction which might not lead to efficient participation from all the types of bidders with an interest in the spectrum concerned, and so risks an inefficient outcome. Neither do we consider that we should hold the two awards concurrently, as this would complicate bidding strategies and stretch bidders’ resources. Hence our preferred timing is to hold the two auctions sequentially, but in close proximity. The question then is which award should come first.

6.47 As discussed in paragraphs 7.14 to 7.15, when holding a series of awards for similar spectrum, we would generally prefer to award first the spectrum that is likely to be in higher demand. This avoids the situation where a bidder first obtains its second preference in the first award simply to guard against the possibility of being unable to obtain its preferred spectrum in the later award – which would increase the risk of an inefficient spectrum allocation. We consider that in terms of the cleared and ‘large’ interleaved lots, demand for the latter is more likely to be a function of the outcome of the award of the former. Hence we propose to hold the relevant award for geographic interleaved lots shortly after the cleared award. We would reconsider this sequencing if the timing of the awards changed.

Question 9. Do you agree with the proposal to hold the combined award for large lots of geographic interleaved spectrum shortly after the cleared award in 2009? What should the time interval be?

Expressions of interest

6.48 As discussed in paragraph 6.12, we propose to award spectrum where there is a reasonable expectation of demand. Where appropriate we will assess demand on the basis of expressions of interest that stakeholders submit. This will apply to additional transmission sites for inclusion in the combined award and to all sites to be included in the final phase award. (It will not apply to the sites we have already identified for the combined award or to the early award of Caldbeck, Winter Hill and Wenvoe.) We propose to take separate approaches to expressions of interest for each of these awards.

Combined award

6.49 For the combined award, the set of lots to be auctioned is reasonably clear. The administrative costs of adding or subtracting lots for this one auction are not likely to be material in relation to the potential enhancement in efficient use of spectrum that comes from offering to market lots where there is reasonable demand. It is possible for example that parties wishing to aggregate lots may see value in adding lots in respect of particular sites not presently included in the combined award. In particular, there may be interest in wider coverage, by single operators, of Scotland and Northern Ireland than would be allowed if the transmission sites in the combined award were limited to those in the indicative list of 25. We will consider extending the set of lots to be auctioned in the combined award where we interested parties make a persuasive case that aggregation possibilities would be enhanced by the inclusion of additional lots. We would need to receive such expressions of interest by March 2009 in order to plan for the combined award.

Phased awards

6.50 For the phased awards, we have identified a list of potential transmission sites (see Table 6.1 and paragraphs 6.8 to 6.12 above). We propose to auction these lots only if we receive relevant expressions of interest. Where there is no interest in a lot being awarded it would not be appropriate or efficient for us to establish and administer an auction. In order to strike a balance between the desirability of auctioning lots that may be of interest to bidders and the costs of the auction process, we expect to consider locations for award where we have received expressions of interest that support the need for such an allocation route, including supporting evidence.

6.51 We expect that evidence would include at least a description of the service to be provided, together with evidence of the financial support necessary to take part in the award. These requirements would apply equally to new expressions of interest and to those submissions we have already received that have so far been of a more tentative nature.

6.52 Our present intention is that we would then evaluate any expressions of interest received on the basis of the case put forward. During such a process we may seek more information from the relevant parties in order to understand better the basis of their expressions of interest. The process of completing expressions of interest could also be of benefit to the stakeholders concerned.

6.53 For the final phase we may hold awards in early 2010 and early 2011. The former will be for those localities where DSO occurs in 2011; the latter for localities where DSO occurs in 2012. The outcome of the expressions of interest process will assist us in determining whether we should hold these awards. We propose that the deadline for expressions of interest should be:

- September 2009 for the award in 2010; and
- September 2010 for the award in 2011.

6.54 We would, under this process, evaluate any expressions of interest and make clear in good time for the relevant auction our intention to offer, or not, relevant lots and confirm the associated technical conditions (whether those suited for DTT or alternative spectrum usage rights) for the relevant licences at this time.

Table 6.2 Outline timetable for awards and expressions of interest

Award	Timing of award	Deadline for expressions of interest
Initial phase	Late 2008 or early 2009	Not applicable
Combined award	2009, soon after the award of DDR cleared spectrum	March 2009
Final phase	(i) Early 2010 (ii) Early 2011	September 2009 September 2010

Question 10. Do you agree with our approach to expressions of interest in order to finalise the spectrum lots appropriate to allocate by auction?

Conclusion

6.55 The main points in our proposals for spectrum packaging and the timing of release of the spectrum are:

- We should optimise the possibilities for use of the geographic interleaved spectrum. Table 6.1 sets out a list of 81 transmission sites, with related channels, that we consider to be candidates for award.
- The spectrum lots should be awarded in a phased manner:
  - The initial phase would be the award in late 2008 or early 2009 of 'medium' spectrum lots for Caldbeck, Winter Hill and Wenvoe
  - The combined award would be a single award of 'large' lots in the locations identified as being most suitable for aggregation. This award would be designed to address specifically the requirements of those operators wishing to develop services in a number of locations. It is likely to include all of the 25 indicative locations we identified in the DDR 2007 statement, possibly with additional locations where there is evidence of demand. We intend to offer one 8 MHz channel per location, and the channel will be chosen in order to maximize possibilities for geographic aggregation. We mighty extend the list of lots to be auctioned in the combined award on the basis of any new evidence of demand put to us. We presently anticipate that this would need to be given to us by March 2009.

- The final phase would be the award of ‘medium’ and ’small’ lots ahead of the latter stages of the DSO timetable. This would likely comprise a single batch of lots in early 2010 and another batch in early 2011. The lots to be auctioned would be chosen on the basis of expressions of interest. Evidence supporting expressions of interest would need to be received by September 2009 for lots in 2010 award, and by September 2010 for lots in the 2011 award.

Section 7

Auction design and rules

Introduction and summary

7.1 In this section we develop proposals for the auction designs that we could use to allocate the spectrum lots (discussed and defined in Section 6) in a way that meets our objectives for the digital dividend.

7.2 Spectrum auction design is a specialist and evolving area. We have taken into account experiences both from our own awards programme and relevant international awards, and the specific characteristics of the geographic interleaved awards. This includes the nature of the likely bidders. We have developed our proposals with advice from our auction advisers, DotEcon.

7.3 In this section we:

- describe the auction design options suitable for the initial award of medium lots in Caldbeck, Winter Hill and Wenvoe;
- consider the auction design options for other phased awards of medium/small lots ahead of the latter stages of DSO;
- consider the auction design options for the combined award of large lots in the locations identified as most suitable for aggregation; and
- propose rules and procedures for the initial award, including application and qualification procedures, sample bidding rounds, reserve prices and deposit payments. We also illustrate how an ascending bid auction for the first award would work.

7.4 We discuss in Annex 7 factors that can affect the efficient outcome of an auction and describe in more detail the auction designs that we have considered for the proposed awards.

Auction formats for the initial award of licences for Caldbeck, Winter Hill and Wenvoe

7.5 In deciding what auction design we should use for this initial award our main consideration has been the likely demand for these three lots. We propose to make three 8 MHz lots available, covering each of the Cardiff, Manchester and Carlisle areas. It is likely that the participants in this award would be interested in just one of the lots. None of the lots is a close substitute or complement for another and there are no significant synergies between any of the lots. In this case an auction with bidding for single lots rather than packages of lots is most appropriate.

7.6 There are two candidate single unit auction formats: a sealed bid auction or an ascending bid auction.

7.7 A sealed bid format is a very simple format. Bidders are invited to submit a sealed bid for an individual lot during a single round of bidding. A number of lots may be sold at the same time but the sale of each is effectively a separate auction. Bidders decide how much to bid for a lot, and their bid is valid so long as it is equal to or greater than the reserve price. The winning bid for a lot is the highest bid for that lot, with any ties resolved using a specified random process.

7.8 An ascending bid auction is a multi-round alternative to the sealed bid auction of a single spectrum lot. In the first round, bidders are invited to submit bids at a reserve price. If there is more than one bid the auction continues and in subsequent rounds prices are increased. In every round, the bidders can therefore evaluate the increasing price for the spectrum lot and determine whether to stay in the auction or drop out. Bidding continues over a number of rounds until there is only one bidder left. In the event that all remaining bidders stop bidding at the same time, a specified random process is used to resolve the tie.

7.9 The advantage of an ascending bid auction over the sealed bid auction is the scope it gives for price discovery. Where bidders have similar but uncertain business cases it may be useful for them to have information on their competitors' bids. This could allow them to refine their own valuations of the spectrum. It is difficult to judge how significant common value uncertainty and price discovery might be for different potential bidders in these awards. The test is whether a bidder is likely to revise its own business case and hence bid strategy if it has information about others' valuations.

7.10 The benefits of price discovery are probably modest in this case, given that there is just one licence available for each geographic area, lots have significant differences, and there could be a diversity of business cases. Nevertheless, it is likely that there could be bidders with similar business cases who share some degree of common value uncertainty. Further, this would be the first spectrum auction in the UK for this type of licence which may contribute to uncertainty about the value of the spectrum. For these reasons we favour using the ascending bid auction format.

7.11 We would not need to hold an auction for a lot if only one applicant was qualified (see paragraph 7.40) to bid. In this case we would award a licence to the one applicant who would pay the reserve price.

7.12 We propose, subject to the outcome of this consultation, to run three single unit ascending bid auctions for these lots.

Question 11. Do you agree that we should run single unit ascending bid auctions for the award of each of the spectrum lots for Caldbeck, Winter Hill and Wenvoe?

7.13 We also need to consider whether to run the three auctions sequentially or in parallel and would welcome stakeholders' views on this question.

7.14 Both approaches should produce a similarly efficient auction outcome and spectrum allocation. The choice between running sequential or parallel awards therefore depends on other factors. One of these is the expeditious completion of the awards. Our main consideration in the timing of these initial awards has been to provide existing RTSLs in Carlisle, Cardiff and Manchester with the opportunity to obtain clarity on their future spectrum holding in advance of early DSO. We should be able to complete parallel awards more quickly than a sequence of awards and, in that case, the RTSLs would know earlier whether they had won a licence. Another factor might be the practicality of bidders taking part in different awards running at the same time. It may be unlikely that a bidder would participate in more than one of the awards, as there are no obvious synergies between the spectrum lots. But even if this were not the case, given the small number of lots, bidders should not find it difficult to participate in three parallel auctions.

7.15 If the auctions were run sequentially, we see no great issue with the order in which we run them, although it might be preferable to run them in the order in which DSO takes place, i.e. awarding Caldbeck first and Wenvoe last. If the auctions took place in parallel, they would all start at the same time and rounds would be scheduled at the same time. However, there would be no linkages between bids in the three auctions, and we propose that we reserve the right to apply different bid increments for each lot. Bidding in the three auctions would probably close at different times. Regardless of whether the auctions are run sequentially or in parallel, our proposals for the application and qualification procedures (which are described below in paragraphs 7.35 to 7.40) would be identical for each auction and we could handle this part of the process as a single operation.

Question 12. Do you have comments on whether the initial auctions of spectrum lots for Caldbeck, Winter Hill and Wenvoe should be run in sequence or in parallel?

Question 13. If the initial auctions are run in sequence do you have a preference for the order in which they run?

Auction design options for the combined award of 'large' lots suitable for aggregation

7.16 In this award, we propose that all licences would be sold at the same time in a single auction. We expect that there is likely to be demand both from:

- Bidders seeking to create a footprint over a wide contiguous geographic area or in a number of metropolitan areas or even nationally, who may have substantial synergy value from aggregating specific combinations of licences.

- Bidders that have purchased spectrum in the cleared award with gaps in geographic coverage that they would like to fill by obtaining suitable geographic interleaved spectrum.

- Local bidders, seeking one or more individual lots, who have no substantial synergies between licences

7.17 In this context, it is not appropriate to use a single unit auction format. Such approaches would create great uncertainty for aggregators in deciding how much to bid for individual licences and unduly expose them to the risk of winning an unwanted or low value subset of their full demand. This could mean that aggregators are unable to express their true value of the available spectrum, with the result that the auction outcome may be inefficient.

7.18 We also consider that a multi-round process would be more likely to promote an efficient outcome than a single round sealed bid process. Given the potentially large number of licences available, it is likely that some bidders could benefit significantly from price discovery over multiple rounds. Further, there are likely to be groups of bidders with similar business cases, who may have some degree of common value uncertainty, who could benefit from observing how other parties behave during the auction.

Characteristics of a simultaneous multi-round auction (SMRA)

7.19 Like the single unit ascending bid auction, an SMRA takes place over a number of rounds. However, it entails a number of lots being bid for in each round. Bidders place bids on one or more of the available lots. Prices increase from round to round and in response bidders are able to switch demand between lots, subject to any rules on switching that are established for the auction. The auction closes for all lots at the same time when no new bids are made for any of the lots. Each lot is then assigned to the highest bidder for the lot.

7.20 An SMRA should produce reasonably efficient outcomes where there are a number of substitutable lots and common value uncertainty. Bidders benefit from being able to observe the behaviour of their competitors and switch their demand between lots in response to changes in the relative prices of lots. This mitigates substitution risks and may reduce – but not eliminate - aggregation risks.

Characteristics of a combinatorial clock auction (CCA)

7.21 In a simple clock auction bidding for a number of similar lots takes place in a series of rounds. The auctioneer announces the price per lot at the beginning of each round and bidders say how many lots they would like to buy at that price. Bidding continues until the aggregate number of lots bidders are willing to buy at the announced price bidder is no more than the number available. Each bidder remaining in the auction at the end wins the number of lots it bid for in the final round.

7.22 The CCA is a development of this format. It allows package bidding over a number of rounds. This both eliminates aggregation risks and alleviates common value uncertainty. The CCA consists of two phases of bidding: the primary bid rounds; and a supplementary bids round:

- *Primary bid rounds* – The primary bid rounds follow a clock auction format. Bidders make a single bid in each round for a package of one or more lots. Where there is excess demand for at least one of the lots in the auction, prices for the affected lots are increased in the next primary bid round, and the rounds continue until there is no excess demand for any lots.

- *Supplementary bids round* – The supplementary bids round is in the form of a single round sealed bid auction with package bidding. Bidders have the opportunity to make multiple bids for alternative packages of lots, subject to constraints created by their primary round bids.

7.23 Following the conclusion of the supplementary bids round, the auctioneer identifies the highest value combination of bids that can be accommodated, drawing on all valid bids from the primary and supplementary bids rounds and taking at most one bid from each bidder.

7.24 We propose to use this format in the award of the DDR cleared spectrum, for the reasons set out in our parallel consultation on the cleared award auction.

Which auction design is preferable for this award?

7.25 There are potential arguments in favour of both an SMRA and CCA for this award:

- The clear advantage of the CCA is that it eliminates aggregation risks for those bidders wishing to create a footprint over a wide are or in a number of localities or even nationally. They will want to combine lots into packages. By contrast, under any variant of the standard SMRA, aggregators will face uncertainty about how much to bid for individual lots and will be exposed to some extent to winning stranded licences. Changes to activity rules, for example introducing staged activity requirements or permitting withdrawals under certain conditions, can reduce but cannot eliminate aggregation risks.

- Against this, introducing package bidding through a CCA may create threshold risks for smaller bidders:

  - Threshold risk can affect bidders seeking individual lots or small packages of lots. In this case they may be local bidders, seeking one or perhaps more individual lots, who do not see substantial synergies between lots. These bidders may find it difficult to compete against a bidder that is seeking a larger package made up of the lots that they want. The smaller bidders would defeat the larger bidder if the sum of their valuations was higher than his and all bid to their true valuations. The problem is that some of the smaller bidders may keep their bids below their valuation in the hope that others may make sufficiently high bids for the large bidder to be defeated, but thereby reducing the amount they pay if successful. If enough smaller bidders attempt to free ride in this way it may be that the large bidder will win. This would be undesirable if the more efficient outcome was for the smaller bidders to win.

    In this case, the likelihood of threshold risks distorting bidder behaviour is probably modest provided that we use a second price rule (i.e. where the winner pays the amount of the highest losing bid), because the gains from such behaviour can only be achieved if bidders at the same time expose themselves to the risk of not winning. In an open CCA, local bidders might try to limit themselves in open rounds so as to force others to pay more. However, this type of strategy would only be effective if other bidders are able to monitor bidding behaviour and change their strategy accordingly, as anticipated by the local bidders. Restricting transparency in relation to the identities of bidders during the auction would make such strategies difficult to follow and risky.

  - A related issue relates to bidders who want to obtain a number of lots to cover a wide area or a number of cities. The concern is that such bidders may not bid for some possible smaller packages even though a rational bidding strategy would suggest that they should make such bids. For example, a large bidder might simply judge that it is likely to win a larger package and fail to consider the benefits of also making bids for smaller packages to insure itself against unexpectedly strong bids from other bidders. As a result, smaller bidders may struggle to win specific individual lots even if they value those lots more highly than the incremental value placed on them by the aggregator, because this incremental value has effectively been overstated by the aggregator

- The licences sold will be tradable and so inefficiencies in auction outcomes could in principle be resolved in the secondary market. An aggregator may be able to purchase lots from a number of successful small bidders (who are known). Despite the risk of some of the small bidders holding out, this is generally easier than it is for potential individual smaller purchasers (who may be unknown to each other) to coordinate a purchase of lots from a winning aggregator. Therefore, the risk of enduring inefficiency in spectrum allocation may be greater where the auction format biases the outcome inefficiently towards aggregators.

7.26 The composition of lots proposed for the auction may to some extent affect the competitive dynamics between bidders wishing to aggregate lots and those wanting single lots only. In particular, threshold risks may be slightly less of a concern. There are two reasons for this. One, some single lot bidders may have alternatives that they can pursue in the later auction of lots covering the same or similar geographic areas.

Two, aggregators will be relatively limited in the lots that they can include in their package bids. This improves the relative case for using a CCA format.

7.27 In summary, we consider that a CCA format, with a second price rule, could be used to award the licences proposed for this award. A standard SMRA auction, with suitable activity rules, is a possible alternative. However, we believe a CCA would more effectively address aggregation risks, and that is our preference.

7.28 Following this consultation, we will need to develop a full description of the auction format and rules to be used in the award of 'large' lots, i.e. the 'combined' award. The auction will, as set out in section 6, probably follow the award of cleared spectrum. Since the cleared spectrum is likely to be awarded using a CCA format, a description of the basic format and of the likely associated rules is included within our parallel consultation document on the award of cleared spectrum[31]. This description provides a good indication for the type of format and rules that would apply to the 'combined' auction for the geographic interleaved spectrum if we adopt a CCA format. Annex 8 describes briefly the main features of a CCA. For comparison, we also describe in Annex 9 the main features of an SMRA. We intend to consult later in 2008 on our detailed proposals for the format and key auction rules for this auction, having considered responses to this consultation.

Question 14. Do you consider that a combinatorial clock auction would be more suitable than a simultaneous multiple round auction for the combined award of large lots suitable for aggregation?

Proposed auction design for the phased award of 'medium'/'small' spectrum lots at locations, linked to DSO timetable

7.29 This award has similarities to the initial auctions of the first three lots discussed above. Although there may be a larger number of lots available, interest is still likely to include bidders interested in local service provision. Aggregating bidders are likely to have focused their attention on the previous 'combined' award, although it is possible that they might then see the phased awards as an opportunity to augment any geographic footprint that they may previously have acquired.

7.30 We propose using a single unit ascending bid auction format for these awards, for the following reasons:

- As this award would need to cater for the expected interest from local bidders, substitution and aggregation risks should not be a significant concern. Therefore, it is not necessary to use package bidding or allow switches between lots. Indeed, if package or switched bidding was used, there might be concern about inefficiency as a result of strategic bidding behaviour.

- However, some bidders may have similar business cases but be uncertain about their valuations and they would benefit from price discovery. These benefits are probably modest, not least as bidders would already have gained some information about the market price of spectrum of different characteristics in different locations from the preceding awards, but could still be real, given the regional progress of DSO and the region-specific nature of some of the business opportunities. Hence the potential scope for efficiency benefits is probably

[31] *Digital Dividend Review: 550-630 MHz and 790-854 MHz Consultation on detailed award design*, Ofcom, 6 June 2008, http://www.ofcom.org.uk/consult/condocs/clearedaward/condoc.pdf

sufficient to outweigh any benefits in terms of administrative simplicity from running the simpler single unit sealed bid format.

7.31 We propose to award these lots in two batches. Within each batch we would run a separate auction for each lot and run the auctions either sequentially or in parallel within a short space of time. This approach would avoid having to administer a large number of separate awards at different times. For example licences for locations with DSO before 2011 would be awarded in early 2010, and those for locations with DSO in 2012 would be awarded in 2011. These awards are therefore some way off.

7.32 Our proposal to use the single unit ascending bid auction format is provisional on the outcome of this consultation. We shall consult again later in 2008 on our proposal for the format and key auction rules, although to the extent that we do adopt this approach, the format and key rules are likely to be based in the first instance on those suggested below for Caldbeck, Winter Hill and Wenvoe.

Question 15. Do you agree with the proposal that the phased award of medium/small spectrum lots at locations linked to the DSO timetable should be by single unit ascending bid auctions? If not, which would be your preferred auction format and timing?

Process and rules for the initial single unit ascending bid auctions for the Caldbeck, Winter Hill and Wenvoe licences

7.33 In this sub-section, we set out in summary the process and main rules that we are minded to adopt for each of the three single unit ascending bid auctions. We invite stakeholders to comment on them. Draft award regulations will set out the detailed rules. They will be subject to consultation before we finalise them.

7.34 Each auction would consist of four stages:

- Application stage
- Qualification stage
- Ascending bid stage
- Grant stage

Application stage

7.35 We propose that prospective bidders submit their applications to participate in the award process. Applicants will also be required to pay an initial deposit by the end of the application day. An application constitutes a commitment to acquire a licence at a price no less than the reserve price.

Qualification stage

7.36 We will determine which applicants are qualified to bid based on the rules set out for qualification. We will then announce the number and identity of the qualified applicants. Those qualified applicants then have an opportunity to withdraw from the process by a date that will be defined by us. The remaining participants after the last day for withdrawal are bidders and we will announce the number and identity of the bidders.

7.37 In deciding whether an applicant is qualified to bid we propose to take into account a number of factors. These include whether:

- the grant of a licence to the applicant would be prejudicial to the interests of national security;
- the applicant is a fit and proper person to hold a licence;
- the applicant has submitted false or misleading information to Ofcom;
- any member of the applicant's bidder group has colluded with another person to distort the outcome of the auction process;
- any member of the applicant's bidder group has disclosed confidential information to another person, except where the disclosure is
    - to Ofcom;
    - to another member of the applicant's bidder group;
    - to a provider of finance for the purpose of raising finance for the application; or
    - to a person for the purpose of enabling him to decide whether to participate as a member of the applicant's bidder group;
- any member, or director or employee of a member of the applicant's bidder group who is also a director or employee of a member of another applicant's bidder group is taking part in the preparation of both bidder groups for participation in the award process or receiving confidential information relating to both bidder groups.

7.38 We will also check whether there are overlaps in membership between applicants' bidder groups. We propose to include equivalent rules to those provided for in our previous auctions, most recently the L Band auction[32]. A bidder group will therefore cover the applicant, each associate of the applicant and other insiders. An associate is as any person who has a material interest in the applicant. This will include any person who (whether directly or indirectly):

- holds shares carrying more than 25 per cent of the votes entitled to be cast at a general meeting of the applicant;
- holds shares in the applicant and whose consent is required for the conduct of any business of the applicant; or
- has the right to appoint or remove a majority of the board of directors of the applicant. Where we determine that there is common membership between bidder groups we will notify the applicants concerned and specify a deadline by which all the common memberships must be resolved (i.e. by which a common associate must have disposed of or otherwise removed its material interest in one or both of the applicants concerned, or by which one of the applicants concerned must withdraw from the award process).

7.39 Where a bidder is being supported by a public body they will need to check that any funding is compliant with EC State Aid legislation.

[32] *Award of available spectrum: 1452 – 1492 MHz The document consults on the proposed grant of wireless telegraphy licences to use this spectrum and on the associated auction process,* Ofcom, 31 March 2006, http://www.ofcom.org.uk/consult/condocs/1452-1492/

Where there is only one qualified bidder

7.40 If there is only one applicant qualified to bid we will not hold an auction. We will award the licence to the bidder at the reserve price; the balance of the reserve price will have to be paid before we award the licence.

Ascending bid stage

7.41 If there is more than one bidder we shall award the licence following an auction. The auction will be run using electronic bidding over the internet. Bidding will take place within discrete rounds. In normal circumstances, bidders will be obliged to submit their bids between the specified start and end times for each round. However, there will be provision for extensions to rounds and submission of bids by other means in the event that bidders are unable to submit their bids in the normal timeframe owing to exceptional circumstances (e.g. technical failure outside the reasonable control of the bidder).

7.42 In the first round of the auction the price of each lot will be set at an amount equal to the reserve price plus an increment. In subsequent rounds (if required), the price will be set at an amount equal to the price in the previous round plus a bid increment rounded up to the nearest £1,000. We will have discretion in setting the bid increment between rounds, but it will be a fixed amount up to 100 per cent of the bid amount in the previous round (or reserve price if this was the first round). Bid increments may vary between rounds.

7.43 Having the flexibility to alter bid increments up or down in different rounds should allow us to effectively steer the pace of the auction and react to the level of bidding activity. Larger bid increments will tend to produce fewer rounds and hence shorter auctions, but risk discriminating against those bidders who are unwilling to make large increases in their bids. We will aim to balance these considerations in setting bid increments, perhaps having relatively high bid increments in the earlier rounds compared to the later rounds.

7.44 In each round of the auction, bidders state whether they accept or reject the new bid amount. In the event that a bidder rejects the bid amount for the current round, it will be given the opportunity to specify a maximum bid for the licence at a discretionary amount in whole pounds sterling, which must be greater than the bid amount in the last round (or reserve price if this is the first round) and less than the bid amount that it rejected**.** We call this a discretionary bid.

7.45 If there is a round in which only one bidder accepts the bid amount, that bidder will be the winning bidder. It will pay an amount equal to the next highest bid submitted by another bidder. This approach ensures that a winning bidder always pays the minimum amount necessary (see Annex 7, paragraph A7.7 for discussion of the second price rule). The amount will constitute the licence fee.

7.46 It is possible that all remaining bidders could stop bidding for a licence in the same round. In this case, the bidder that submitted the highest discretionary bid for that licence will be the winning bidder, and it will pay the amount of the next highest bid. If all bidders stop bidding in the same round and two or more of them submit the same highest bid, then a random process will be used to determine the winning bidder from amongst these tied bids. In this case, the winning bidder will pay the amount of its bid.

7.47 The auction will continue until a winning bidder emerges. It follows that bidders' activity will determine the number of rounds in the auction. This is unpredictable, and the auction could be completed in the course of one day or could continue over a number of days.

7.48 The timing of rounds and the interval between rounds, along with flexible bid increments, will allow us to manage the pace of the auction. As with bid increments, we propose to have discretion on timing. Round lengths need only be as long as is necessary to allow bidders to input, check and submit their bids. We consider that 15 minutes should be sufficient. The interval between rounds will need to be long enough for bidders to digest the result of the latest round and to decide how to bid in the next round. We expect to give bidders 30 minutes notice of the start of a round. We would give this notice some time after release of the latest round result. In practice this would mean holding a round about once every hour. As activity in the auction diminishes it may be possible to decrease the interval between rounds and so increase the number of rounds per day.

7.49 Table 7.1 illustrates how the auction might work. The bidders and bids are fictitious and are not intended to provide any information about the potential value or level of competition for licences.

Table 7.1 Illustration of ascending bid auction

Three bidders	The reserve price for Wenvoe, Winter Hill and Caldbeck licences is £25,000 each. Three bidders – Amy, Ben and Colin – submit an application to bid for the Wenvoe licence. Colin also submits an application for Winter Hill. There are no bidders for Caldbeck. Amy and Ben submit a deposit of £25,000. Colin submits a deposit of £50,000.
Is an auction needed for any of the three lots?	An auction is required for the Wenvoe licence, as there are three bidders. No auction is required for Winter Hill; this licence will be awarded to Colin at the reserve price. The Caldbeck licence is unsold.
Auction for Wenvoe	The auction for Wenvoe will be conducted using electronic bidding over the public Internet. Amy, Ben and Colin will be provided with a web address, passwords and digital certificates (that they can install on a PC) in order to have secure access to the bidding system. In advance of each round, the bidders will be notified of a start time and end time for the round during which they must submit their bid.
Commitment to bidding	As part of their applications, Amy, Ben and Colin have all submitted binding bids to buy the Wenvoe licence at the reserve price of £25,000.
Round 1	In round 1 of the auction, the price of the licence is equal to the reserve price of £25,000 plus a bid increment. Suppose that Ofcom sets a bid increment of 40 per cent. The price of the Wenvoe licence is increased to £35,000. All three bidders decide to accept this price.

	At the end of the round, bidders are notified that there were three bids at the current price of £35,000 and that the auction will continue to round 2.
Round 2	In round 2 Ofcom also sets a bid increment of 40 per cent. The price of the Wenvoe licence is increased to £49,000. Now suppose that only Amy and Ben accept this price. Amy's bid form in respect of this round and her acceptance of this price are illustrated in Annex 10. Colin rejects this price and instead decides to submit a discretionary bid. This bid must be less than £49,000 and greater than his previous bid of £35,000. He decides to bid £40,007. At the end of the round, bidders are notified that there were two bids at the current price and that the auction will continue to round 3. (Note that bidders are not told the identity of the bidder who exited the auction).
Round 3	In round 3, Ofcom reduces the bid increment to 20 per cent. £49,000 plus 20 per cent equals £58,800, so this is rounded up to the nearest £1,000. Thus the new bid amount is £59,000. Both Amy and Ben decide to accept this price. At the end of the round, bidders are notified that there were two bids at the current price and that the auction will continue to round 4.
Round 4	In round 4, Ofcom also sets a bid increment of 20 per cent. £59,000 plus 20 per cent equals £70,800, so this is rounded up to nearest £1,000. Thus the new bid amount is £71,000. Amy accepts this price but Ben rejects the price. Ben submits a discretionary bid of £69,002. Ben's bid form in respect of this round, his rejection of the price of £71,000, and his submission of a discretionary bid of £69,002 are illustrated in Annex 10. At the end of the round, bidders are notified that there was only one bid at the current price and that no further bidding rounds are required.
Result of the Wenvoe auction	After the close of the final round, the results of the auction and the highest bids of all bidders will be announced. Amy is the winner of the licence and she pays £69,002. Although Amy's highest bid submitted was £71,000, she only has to pay the amount bid by the second highest bidder, Ben. That is, Amy pays £69,002.

7.50 At Annex 10 is an example of a bidding form that might be used in the ascending bid auction.

Grant stage

7.51 After the conclusion of the ascending bid stage, the award progresses to the grant stage, in which we receive the winning bidder's payment, issue a licence to the winning bidder and publish the auction results.

Other auction rules

Rules prohibiting collusion

7.52 We propose to include rules that expressly prohibit collusion between bidders. These rules will be in addition to general competition law prohibitions on collusion.

7.53 If a member of a bidder group, or any other person to whom its confidential information has been disclosed, discloses confidential information outside the bidder group (other than to Ofcom, to a provider of finance for its bid or to someone who is considering participating in the bidder group), this may lead to an applicant not being qualified to bid, or to a qualified bidder being excluded from the award process and forfeiting its deposit.

Reserve price

7.54 Each lot available for award will carry a reserve price, below which it will not be sold. Our primary objective in the auction is to promote the optimal use of the spectrum. We consider that the main function of the reserve price to meet the objective is to deter frivolous bidders and we should set it at the minimum level necessary to do this without deterring genuine bidders.

7.55 In the awards we have held to date we have generally set the reserve price per lot at £50,000. There has been some variation of this where numerous lots of varying sizes have been available in an award. For example, in the 10 GHz to 40 GHz award reserve prices ranged from £10,000 to £60,000, reflecting both the size of frequency lots and the potential attractiveness of the four frequency bands included in the award.

7.56 In the initial award we are proposing to run three single unit ascending bid auctions. Each lot varies in geographic and population coverage and hence in its potential economic value. Demand for these lots may be from smaller bidders with relatively fewer resources compared with previous auctions with national lots, and so reserve prices to deter vexatious bids could be correspondingly lower. Nevertheless the administrative costs of organising this small set of auctions will not differ substantially from previous national auctions. Overall we believe that these considerations point to reserve prices somewhere in the lower half of reserve prices used in previous awards. Hence we consider it would be reasonable to set a reserve price for each lot at £25,000.

Deposits

7.57 Deposits are upfront payments that will be forfeit if a bidder breaks specific auction rules or a winning bidder defaults on its payment. We require deposits and set their levels to help to deter frivolous applicants and to reduce the incentive for bidders to default. They are returned to applicants who do not qualify to bid and to unsuccessful bidders, less any sums that might have been forfeited for breach of the auction rules. The winner's deposit (less any forfeit) is offset against the licence fee it has to pay.

7.58 There are a number of points in the process when we will require deposits:

- Applicants pay an initial deposit on the day designated for the submission of applications. If an applicant bidder does not do so we will not accept its application. In our previous auctions we have generally set the level of the initial deposit at 50 per cent of the reserve price.

- Before the auction starts we will require bidders to increase their deposits so that they are at least equal to the reserve price.

- During the ascending bid stage we may ask bidders to make additional deposits to cover the amount of their bids. In such cases we will announce a deadline by which bidders must have raised their deposits so that they remain in line with their highest bid up to that point in the auction. This helps to ensure that bidders do not submit bids for which they are subsequently unable to secure the necessary funds to meet their obligations. It is a way of managing the credit risks imposed by individual bidders on the efficiency of the auction process.

7.59 We recognise that any requirement for bidders to make additional deposits to cover the amount of their bids will make it necessary for bidders to establish suitably large lines of credit. This might be relatively more difficult for smaller bidders or those with uncertain funding. We are willing to take into account any expressed difficulties of this kind in formulating auction rules.

Payment terms

7.60 We propose to issue a licence to the winning bidder on full payment of its licence fee; i.e. the price determined through the auction process or reserve price where applicable. Where, after completion of the ascending bid stage, the amount of the winning bidder’s deposit (less any sum forfeited) is equal to or more than its licence fee we shall issue the licence and, if necessary, refund any excess deposit. Where the amount of the winning bidder’s deposit (less any sum forfeited) is less than its licence fee we will notify the deadline by when it must pay an additional sum to meet the shortfall.

Information policy

7.61 We need to decide how much information to release to bidders on other bidders and their bids. Bidders – and the public more generally – will want the process to be as transparent as possible to help ensure that it has been run fairly and that the reported outcome is correct. Bidders also need information on others’ bids to help their decision making in the auction. The downside of releasing information on bids is that it can assist collusion between bidders or give strong bidders the opportunity to indulge in aggressive tactics designed to undermine weaker bidders.

7.62 There are some minimal necessary information requirements. We need to notify applicants of the identity of other applicants in the qualification stage so that they can check for cross membership of bidder groups. In the interests of transparency more generally we would publish the identities of all bidders before the ascending bid stage and, after the auction has ended, details of the winner and bids made by all bidders.

7.63 There is a range of options for releasing information in the ascending bid stage. In order to bid sensibly bidders need some information on activity during each round. It is arguable that they may need to know only how many other bidders have bid in a round. However, we consider that full transparency would make for an efficient auction, with bidders receiving after each round full information on the bids all other bidders have made.

Forfeit of deposit and exclusion from award process

7.64 We propose that a bidder's deposit may be forfeit in full or in part if it breaches any of the auction activity rules, which cover such things as the submission of false or misleading information and collusive behaviour. A bidder may also be excluded from the auction. Any monetary penalties incurred will be deducted from a bidder's deposit before it is either refunded or set off against payment of a winning bidder's licence fee.

Unsold licence

7.65 If the licence remains unsold at the end of the auction, either through an absence of bids or default, we will choose whatever course of action we consider appropriate at that time in line with our statutory duties.

Question 16. Do you agree with the proposals for the main rules that we are minded to adopt for each of the three single unit ascending bid auctions?

Conclusions

7.66 In this section we have considered which auction formats might be most suitable for these auctions. Table 7.2 below summarises our proposals.

Table 7.2 Proposed format for each auction

Award	Proposed auction format
Initial award of 'medium' spectrum lots for Caldbeck, Winter Hill and Wenvoe	Single unit ascending bid auction for each lot
Combined award of 'large' spectrum lots, which would be suitable for aggregation	Either a combinatorial clock auction (CCA) or a simultaneous multiple round auction (SMRA) – we express a preference for the former
Phased award of 'medium'/'small' spectrum lots at numerous locations, timed to match DSO	Single unit ascending bid auction for each lot

Source: Ofcom

7.67 We have also set out in summary the process and main rules that we propose for the initial auctions of 'medium' spectrum lots for Caldbeck, Winter Hill and Wenvoe. We shall take stakeholders' comments into account in drawing up the rules in detail. Draft award regulations will set out the rules. They will be subject to statutory consultation before we finalise them.

Section 8

Technical licence conditions

Introduction and summary

8.1 In order to manage interference between services it is necessary to define appropriate technical parameters as part of the licence conditions for users of the spectrum.

8.2 In this section we describe:

- our proposals for the technical licence conditions (TLCs) that would be appropriate for new DTT services in the interleaved spectrum;
- at a high level, the approach we propose to adopt to technical licence conditions for services other than new DTT services in the interleaved spectrum; and
- our proposals in relation to keeping new services in the geographic interleaved under the threshold for international coordination.

Spectrum management principles

8.3 One of the key objectives for spectrum management is to control interference between different users. This is achieved by imposing a set of technical licence conditions on the licensee to limit the risk that significant levels of interference are caused to neighbours, both in geography and in frequency terms. These neighbours could be either new services using digital dividend spectrum or the existing DTT services following DSO.

8.4 TLCs can either be focused around the licensees' transmitters or the neighbours' receivers. Traditionally, TLCs were applied to transmitters, effectively restricting their in-band and out-of-band emissions. These conditions, generally termed transmit masks, are relatively simple to understand. It is also relatively easy to assess compliance with this type of TLC, by measuring the in-band and out-of-band power of the licensee's transmitters. Transmit masks allow for a level of flexibility, as the spectrum can be used for a range of services or technologies provided the power profile of a licensee's transmitters does not exceed the limits in the TLCs.

8.5 However, transmit masks do not directly control the interference levels experienced by neighbours, as they do not account for transmitter density. The more transmitters of a given power that there are in a given area, the higher the risks of neighbours experiencing significant interference from them. Hence, with this form of TLC, neighbouring licensees will have less information on the interference levels that they can expect from the transmissions concerned.

8.6 An alternative approach involves TLCs centred on controlling the interference experienced by the neighbouring licensees' receivers. These conditions are known as spectrum usage rights (SURs). As in the mask approach, a licensee with SURs has flexibility in terms of spectrum use, in that it can use the spectrum for a service or usage of its choice provided it does not exceed its SURs. However, unlike mask-based TLCs, SURs require the licensee to manage both the power of the transmitters and their density. For the same transmitter power, a denser network will result in higher interference such that a licensee may exceed its SURs. To ensure it remains within its SURs, a licensee therefore has to make a careful judgement of its network roll-out based on a trade-off between transmitter power and deployment density.

8.7 Relative to mask-based TLCs, SURs are more complex to define and compliance assessment is not as straightforward. However, because SURs are specified in terms of the interference experienced by neighbouring licensees they directly control the neighbours' interference levels. Hence, neighbours have a better idea of the interference to expect under such a TLC.

New DTT services in the interleaved spectrum

8.8 To date stakeholder interest for new services (other than PMSE and applications for cognitive devices) in the interleaved spectrum has focused on new DTT services. For this type of fixed single transmission site application it is relatively straightforward to determine the appropriate technical licence conditions for each case based on a modification to the UKPM. The UKPM is a TV interference analysis tool developed by Arqiva, NGW and the BBC to plan UK DSO based on interference into and from each transmission site in the UK. Its use in modified form has already been demonstrated in Section 5 to establish the expected coverage and impact of new DTT services in the interleaved spectrum.

8.9 For a given set of additional interference constraints on the existing, post-DSO DTT services, such as those proposed by the median method, the use of the modified UKPM defines for one of more additional channels from a particular transmission site:

- the maximum radiated power that may be used;
- the transmit antenna template (modified as required by any international coordination restraints that apply);
- the polarisation (horizontal or vertical); and
- the height of the transmit antenna on the mast.

These parameters together with the type of modulation scheme used (e.g. 64QAM2/3) enable the service area and population coverage to be defined. However, in order to fully define the technical licence condition a transmission mask is required which specifies the allowable out of band emissions (i.e. emissions into adjacent channels). In this case a simple block edge mask can be applied using the appropriate DVB-T transmitter mask as specified in Ofcom Interface Requirement 2022[33]. Therefore in this case it is straightforward to define the technical parameters required in the technical licence conditions for a service.

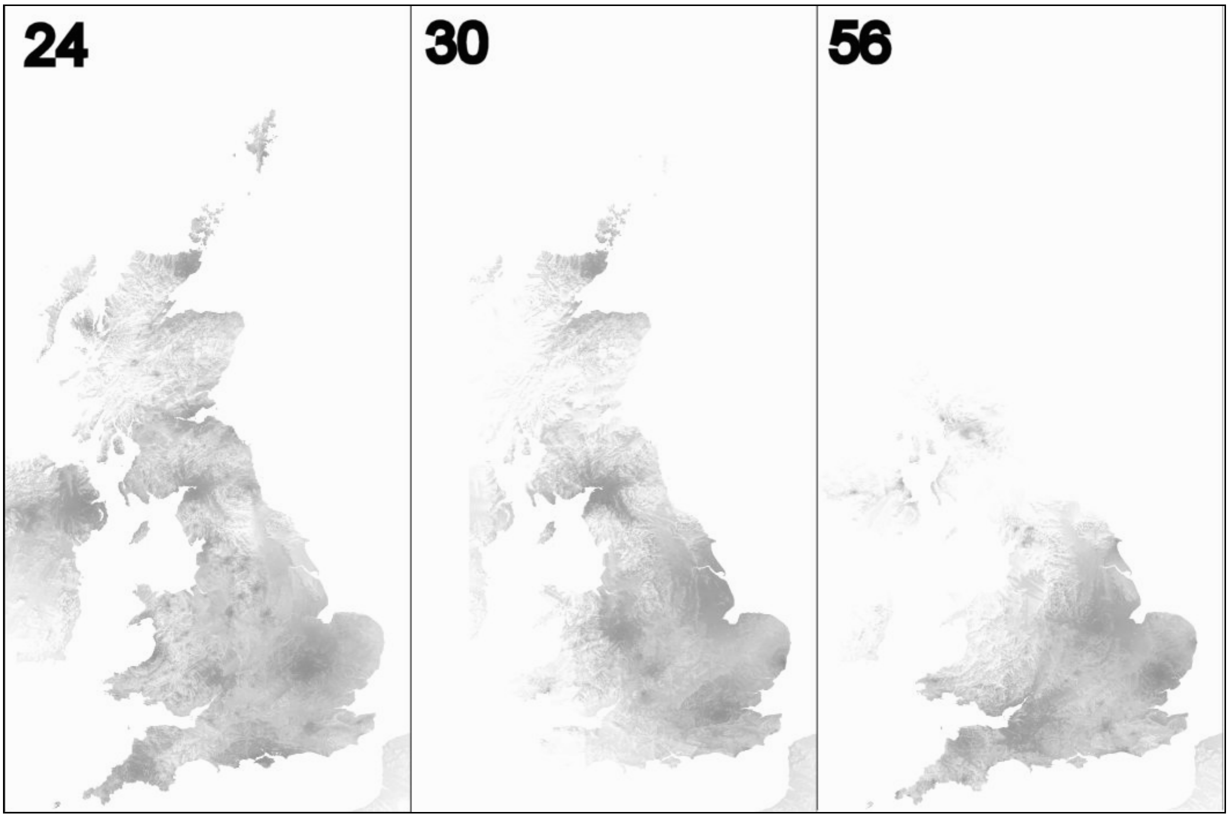
Non-DTT services in the interleaved spectrum

8.10 To date, we have seen limited evidence of interest in using the geographic interleaved spectrum for the provision of new services other than DTT and PMSE (and the potential for applications using cognitive devices) and therefore we have performed relatively little analysis of the suitability of the spectrum for other types of service. However, figure 8.1 provides a top-level illustration of the interleaved

[33] *UK Interface Requirement 2022. Broadcast transmitters operating in frequency bands administered by Ofcom (98/34/EC Notification number: 2007/124/UK),* Ofcom, July 2007, http://www.ofcom.org.uk/radiocomms/ifi/tech/interface_req/ir2022.pdf

channel utilisation in the UK on channels 24, 30 and 36. The darker the colour, the more intense is the use of that channel for existing DTT multiplexes, so white space indicates least intensive use of the channel. Where there is white space it may be possible to establish new services.

Figure 8.1 DTT use of channels 24, 30 and 56 (showing white space)



Source: NGW

8.11 The UKPM is designed to enable modelling of DTT networks. It cannot be directly applied for services other than new DTT services in the interleaved spectrum. It is not clear which specific technology or service will be deployed in the expected term of the licence (see paragraphs 9.34-9.42) and whether it will change in the future, thus highlighting significant uncertainty in the expected interference levels which need to be managed.

8.12 If the spectrum is not used for DTT, there is a greater likelihood of multiple transmitters being deployed to form networks than is customary for DTT services. In this situation we would favour the use of a SUR approach as part of the TLCs. SUR conditions that have been developed for the cleared award can be applied with the additional co-channel constraint of the maximum allowable interference into incumbent DTT services. Interested parties should refer to Section 5 in the cleared consultation document which describes the TLC applicable to that spectrum. We would expect to be consistent and apply the same approach to non-DTT services in the interleaved spectrum.

8.13 We recognise that the use of the interleaved channels by existing DTT services and the guard bands between DTT and other services proposed in the cleared consultation may make it difficult to provide non-DTT services over a significant geographical area. Based on the level of interest we will consider further the implications of non-DTT services in the interleaved spectrum.

Protection of existing DTT multiplexes

8.14 We have considered whether it would be appropriate to insert a further TLC in the licences to be awarded for the geographic interleaved spectrum to protect the reception of the existing DTT multiplexes. We have proposed that such a protection clause' is included in the licences to be awarded for the cleared spectrum[34]. However the circumstances in the geographic interleaved award are different. The rights to use the spectrum for new DTT services that we are proposing to award will be tightly defined using the UKPM and a fixed set of interference entries into existing DTT services. Also we are not proposing initially to include in the licences the right to use the spectrum for services other than DTT. Accordingly, in this case no additional protection is required for the existing DTT multiplexes and we do not, therefore, propose to include a protection clause in the licences for this award.

8.15 We recognise that, as technology develops, there may be other uses for the spectrum, and reasons to change the technical parameters in the licences. Should a licensee wish to change the technical parameters of its licence, or provide other services than DTT, we would consider inserting a protection clause to protect the existing DTT multiplexes. In particular, if the licences were varied to allow provision of new services other than DTT in the geographic interleaved spectrum then since there may be less certainty as to the interference entry into existing DTT services it may well be appropriate to include an additional protection clause to ensure that existing DTT are protected.

8.16 Further information about the matters we considered in relation to the protection clause is set out in Annex 11.

Post award licence variations

8.17 Our approach to spectrum management seeks to be technology and service neutral. However, as stakeholder interest in new services in the interleaved spectrum has centred almost exclusively on DTT we have focused our technical work on optimising the frequency/channel allocation for this type of service. This in turn means using existing DTT transmission sites (to which existing viewer aerials are pointing) and the use of channels that are in (or close to) the group of the aerials used by viewers in the area. The TLCs are then derived from the UKPM with the addition of a transmission mask. Therefore, licences of this type are quite prescriptive in terms of their application.

8.18 Where there may also be interest in services other than digital TV we assume that, in general, prospective service providers will be interested in spectrum that is likely to minimise the potential for interference to TV. These frequencies will typically be out of the local TV aerial group and probably using transmission sites at locations other than existing DTT transmission sites. This type of service is likely to operate under an appropriate SUR and may be expected to offer greater flexibility in terms of post-award licence variation. All proposals for licence variations will be considered on a case by case basis.

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[34] See section 5 of the Cleared consultation, http://www.ofcom.org.uk/consult/condocs/clearedaward/condoc.pdf

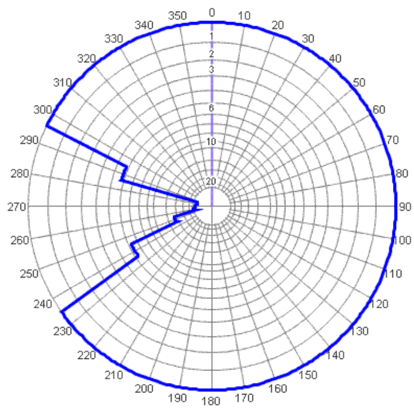
Question 17. Do you have any comments on the technical licence conditions we are proposing to include in the licences?

International coordination

8.19 GE-06 specifies, for new DTT services in the UHF and VHF bands, field strength levels above which international coordination is necessary. As a rough rule of thumb in the UHF band, if the field strength is 23dBuV/m or lower at the neighbouring country's coastline or border, additional coordination is not required with that country. NGW has produced additional antenna templates to limit the field strength to no more than this 23dBuV/m trigger level to avoid international coordination. These will sometimes imply that the number of households that can be covered by a given channel at a given location will be lower than without such a constraint.

8.20 As an example, Figure 8.2 shows the international coordination template for a new DTT service from Winter Hill which must be added on to the UK template. The restriction shown to the west is to limit the field strength to below 23dBuV/m at Ireland's coast.

Figure 8.2 International coordination template for Winter Hill



Source: NGW

8.21 Limiting new DTT services exported field strength transmissions in the interleaved spectrum to below the GE-06 threshold avoids the need for international coordination. Exceeding the threshold would require negotiations with our neighbouring countries, with no guarantee of success. We therefore propose that licences for the geographic interleaved lots will not allow the coordination threshold to be exceeded. However, we may consider requests for opening such negotiations after lots have been auctioned if there are compelling arguments for doing so.

Question 18. Do you agree that the licences for the geographic interleaved spectrum should not allow the co-ordination threshold to be exceeded?

Section 9

Non-technical licence conditions

Introduction and summary

9.1 In this section we discuss non-technical usages rights that we propose to place in the licences that we will auction. In particular, we discuss our proposals on

- DTT multiplex issues – setting out certain ownership restrictions reflecting the regime applied by the Broadcasting Act 1996 and allowing us to facilitate interoperability between existing and any new DTT multiplexes;
- Making the WTA licences tradable in secondary markets;
- Licence commencement and duration;
- The duration of the initial period, our limited rights for revoking the licence during this period and any additional powers we have following the initial period;
- Non-technical restrictions;
- Service obligations; and
- Provision of information to promote efficient use of spectrum.

9.2 Before moving on to the discussion on the non-technical proposals, we believe it is worth recapping on our December 2006 consultation proposals and the stakeholder responses. The December 2006 consultation document proposed a number of specific non-technical usage rights and obligations to be included in the Wireless Telegraphy licences to be awarded. These were:

- We proposed an indefinite licence duration, with a initial term lasting until 2026 (subject to five years' notice of variation or revocation);
- We proposed that all licences would be tradable, with all legal forms of trading to be permitted;
- The licences would not restrict the technology or type of equipment to be used, or the service to be offered (other than the minimum technical restrictions necessary to control harmful interference); and
- We proposed that the licences should not contain rollout obligations or 'use it or lose it' conditions.

9.3 A small majority of responses favoured additional restrictions to ensure efficient spectrum use and promote diverse, non-discriminatory and inclusive use, particularly on a geographic basis to prevent an increase in the digital divide and for the services offered.

9.4 Most broadcasters thought that a minimum licence term of 12-18 years was needed, although other respondents felt that this was too long and that shorter terms were more appropriate to take account of new technologies and to maximise spectrum efficiency. Broadcasters wanted licence terms aligned with those for the existing DTT multiplexes.

9.5 Some community and consumer groups and individuals wanted provisions requiring demonstration of broader social value, to be transferred on any subsequent trade. Most respondents, particularly broadcasters and telecommunications operators, were keen that we formalise any arrangements to reduce interference risks.

9.6 We have taken the above responses into account when developing our proposals for this award.

DTT multiplex issues

9.7 The 2006 DDR consultation noted that the Communications Act gives us the power to operate a simpler and more flexible regime that would allow spectrum to be used to carry broadcast services such as those already available on the DTT platform (which are licensed under the Broadcasting Acts).

9.8 Under this regime it is only necessary to hold a licence under the Wireless Telegraphy Act in order to operate a multiplex that may carry broadcast services. It is not necessary also to hold a multiplex licence issued under the Broadcasting Act.

9.9 The DDR statement confirmed that we expected to use this new regime in relation to the digital dividend spectrum, removing the requirement for a person to hold a multiplex licence under the Broadcasting Act 1996. Content providers would however still need to hold the appropriate Broadcasting Act content licence.

9.10 The DDR statement also noted that we had considered whether it would be desirable to retain some limited elements of the Broadcasting Act regime, and that we would set out proposals in this consultation document regarding the inclusion of certain ownership restrictions to disqualify certain groups from operating a television or radio multiplex and to address interoperability between the existing DTT platform and any new television multiplexes using the digital dividend.

9.11 The proposals below apply equally to the cleared and band manager awards and the consultation documents relevant to these awards set out the relevant proposals.

9.12 We have also considered whether there are other aspects of the obligations contained in Broadcasting Act multiplex licences that should be retained under the approach that we propose to adopt, of awarding licences under the Wireless Telegraphy Act only. In particular, Broadcasting Act licences typically contain conditions relating to competition.

9.13 However, we consider that the proper context in which to consider potential conditions relating to competition issues is in relation to a discussion of the effects of the award on competition more generally, and the potential effects on relevant markets. This is in section 9.

Ownership

9.14 We think that there are important reasons for considering whether to impose any restrictions on the identity of persons who may hold the WT Act licences that are the subject of this award for the purpose of operating a radio or TV multiplex.

9.15 The fundamental point is that, whatever the technical and operational distinctions between existing DTT multiplexes (operated under both a Broadcasting Act licence and WT Act licence) and new DTT multiplexes (which may be operated under a WT Act licence only), the services that they provide may be indistinguishable in the eyes of viewers.

9.16 As noted above, content providers are required to hold the appropriate content licence issued under the Broadcasting Act. This requirement applies to content providers across all broadcasting platforms. At the platform level, however, Parliament has deliberately chosen to distinguish between the provision of those services via a multiplex —disqualifying certain categories of person from holding a Broadcasting Act multiplex licence—and via other networks (e.g. satellite and cable).

9.17 Categories of persons disqualified from holding multiplex licences under the Broadcasting Act 1990[35] include the following:

- local authorities;
- political bodies;
- religious bodies;
- publicly-funded bodies;[36]
- bodies exerting undue influence;
- broadcasting bodies, specifically the BBC and Welsh Authority; and
- advertising agencies.

9.18 The Communications Act obliges us to consider the ownership rules in relation to broadcast media at least every three years. It does so in the recognition that communications markets are developing rapidly and likely to continue to do so, which may in time mitigate the need for specific ownership restrictions and rules. Our first review in November 2006 concluded that there was no clear reason for such changes.[37]

9.19 We have borne these conclusions in mind in considering which, if any, ownership restrictions to apply to the use of the cleared spectrum to operate a DTT multiplex. At the same time, we have had regard to our duty to ensure our actions are targeted only at cases in which action is needed.

9.20 Where the geographic interleaved spectrum is used to operate a multiplex for carrying DTT services, we propose to:

- include ownership restrictions that replicate those in the Broadcasting Act relating to –
  - o local authorities;

[35] www.opsi.gov.uk/acts/acts1990/ukpga_19900042_en_1. Subsequently amended by the Broadcasting Act 1996, the Competition Act 1998, the Enterprise Act 2002 and the Communications Act 2003.
[36] Radio-service licences only.
[37] www.ofcom.org.uk/research/media_owners/rulesreview/rules.pdf.

  - political bodies;
  - religious bodies; and
  - bodies exerting undue influence; but

- not to replicate the restrictions related to –
  - broadcasting bodies. This no longer appears appropriate given that BBC Free to View Ltd already holds a Broadcasting Act multiplex licence (for Multiplex B), and is directly under the control of the BBC;
  - advertising agencies. We do not believe it would be justified to restrict persons in this class from holding a WT Act licence, and all content restrictions in relation to advertising will apply in any event via the regulation of content provision.

Question 19. Do you agree that where the geographic interleaved spectrum is used for the operation of a DTT multiplex, we should replicate the ownership restrictions from the Broadcasting Act regime relating to (a) local authorities, (b) political bodies, (c) religious bodies and (d) bodies exerting undue influence but not replicate restrictions relating to (e) broadcasting bodies and (f) advertising agencies?

9.21 In proposing that we replicate the ownership restriction related to local authorities, we have been mindful of our position, set out in the DDR statement, that explicit support through direct funding for services that can provide broader social value is more transparent and can achieve a better outcome than reserving spectrum for those services. We therefore wanted to ensure that this ownership restriction would not work against any services (e.g. local television) that might require funding from such sources to be viable.

9.22 We believe that it is entirely feasible to separate funding of the acquisition of spectrum from the ownership of a DTT multiplex. The ownership restriction related to local authorities should not prevent potential funding from such bodies for those wishing to provide local television services provided the funding does not give rise to '*de facto*' control of a multiplex or 'undue influence' adverse to the public interest:

- *De facto* control – this will arise if the funding arrangements put the provider of those funds in the same position as a controlling shareholder. This is more than mere influence, allowing the local authority to fulfil its wishes over and above other shareholders.
- Undue influence adverse to the public interest – there must be no influence exerted on the multiplex owner which may serve political or other ends. Limited financial assistance, in the form of a loan or grant, may be acceptable provided it does not result in the exertion of influence which is adverse to the public interest. Each grant or loan would need to be considered on a case by case basis.

9.23 We encourage bidders requiring direct funding to acquire this spectrum to think about how they can secure funds from a variety of sources (including but not limited to local authorities) and to ensure that they comply with all the rules relating to funding.

9.24 In considering how best to implement in Wireless Telegraphy Act licences the ownership restrictions which are equivalent to those currently included in Broadcasting Act multiplex licences, we will also need to consider whether any related conditions are required in order to enable us to monitor and audit compliance with the ownership restrictions imposed, for example, requiring the licensee to inform us of any change in ownership and to provide us with relevant information at our request regarding ownership, control and undue influence.

Interoperability

9.25 Viewers benefit from and greatly value being presented with a common service across all existing DTT multiplexes. This outcome is achieved by the current framework under which the existing multiplexes interoperate. This is necessary because the multiplexes are independent of each other, unlike vertically integrated platforms like satellite or cable, and so some cooperation between the multiplex owners is required to ensure that viewers on any particular multiplex are presented with a common set of services rather than the service offerings of that particular multiplex.

9.26 When the first DTT multiplex licences were awarded in 1998, the Independent Television Commission required compliance with its Technical Code and associated Community Digital Standards. These documents now exist as the Ofcom Television Technical Code[38] and Reference Parameters for Digital Terrestrial Transmissions in the United Kingdom,[39] which define the technical standards and operating parameters that the existing multiplex operators are required to adopt. The latter document details a subset of transmission standards agreed within the European Telecommunications Standards Institute (ETSI) to which operators should adhere:

- frequency parameters – what kinds of signal are used to carry a multiplex (e.g. DVB-T, 64QAM);
- encoding standards – how the programmes carried in the multiplex are put into a form suitable for broadcasting (e.g. MPEG-2, MPEG-4);
- service information – the data stream normally invisible to viewers that is essential for receivers to operate. Some parts of the stream are used to populate the Freeview electronic programme guide (EPG), allowing viewers to obtain up-to-date information on all DTT services regardless of what they are watching;
- Application Programme Interface – the software that displays graphics and enables interactive services to function (e.g. MHEG-5); and
- access services (e.g. subtitling).

9.27 At the same time, there is focused voluntary cooperation on the part of the multiplex operators in addition to compliance with the two documents mentioned above. This takes place through the Digital Television Group (DTG),[40] which publishes, maintains and promotes adherence to the D-Book, setting out the detailed technical standards for DTT in the UK, and runs the sector's test and conformance centre. The operators also pay for and maintain equipment such as the Central Service Information

[38] See http://www.ofcom.org.uk/tv/ifi/tech/codes_guidance/tv_tech_platform_code.pdf
[39] See http://www.ofcom.org.uk/tv/ifi/tech/codes_guidance/dttt_uk2.pdf
[40] DTG is the industry association for digital television in the UK. It is independent and platform neutral. It was formed in the mid-1990s to facilitate the introduction of DTT in the UK and has a wide membership including Ofcom, multiplex operators, broadcasters, consumer bodies and equipment vendors.

Collator, which combines information on programmes on all the multiplexes to produce the service information broadcast on each.

9.28 Against this backdrop, and given the possibility that cleared spectrum will be used to deliver new DTT services, we have considered the issue of interoperability with the existing multiplexes and the extent to which regulatory intervention may be needed to secure this. We have identified three options:

- **Do nothing**. Under this option, interoperability would only arise through the voluntary agreement of existing and new multiplex operators. It could be achieved by new operators adopting the same technical standards and operating parameters as existing operators and existing operators adapting their systems as necessary to accommodate new operators. Given that under this option interoperability will only arise if the new and existing multiplex operators can reach agreement, there is some risk that it will not be secured in the future. Our initial view is given that in the past consumers and citizens have benefited from the existence of interoperability arrangements it is likely to be unattractive to take this risk. We have therefore identified two further more proactive options.

- **Facilitate**. Under this option, we would require existing multiplex operators to interoperate with new operators at the request of the latter. We would propose to vary existing operators' Broadcasting Act licences if necessary to achieve this. If new operators wished to take advantage of this opportunity, they would need to operate within the same technical code and operating parameters as existing operators. They would not therefore be free to adopt some aspects of the technical code and operating parameters while rejecting others. (However, the technical code and operating parameters themselves include a number of choices open to multiplex operators.) This option preserves some flexibility for the new operators since it is not overly prescriptive about whether and when interoperability is achieved but it would set out a clear expectation that it will occur subject to the choice of new operators. It also would enable us to intervene if circumstances frustrate such agreements being reached. It does not, however, guarantee viewers the benefits of interoperability across all multiplexes and nor that this will happen at the earliest possible time. We stress that we would expect new operators gaining interoperability in this way to play a full role in the maintenance and development of the DTT platform rather than adopt a pick-and-mix approach to its individual components;

- **Mandate**. Under this option, we would require existing and new operators to interoperate in full as specified by Ofcom both in terms technical standards and the time at which it should be achieved. Again, new operators would need to adopt the same technical standards and operating parameters as existing operators, while we would vary existing operators' Broadcasting Act licences as necessary. This would guarantee viewers the benefits of interoperability across all multiplexes but at the expense of automatically precluding alternative market offerings that could deliver different, possibly greater benefits. As yet we are not aware of a compelling reason to intervene to this extent.

9.29 On balance, our initial view is that interoperability is likely in the future to bring benefits to consumers and citizens as it has in the past. Therefore, if the spectrum is to be used for new multiplexes we consider it appropriate to take some steps to encourage the emergence of interoperability so that those benefits are realised in relation to such new multiplexes. However, our preference is for the industry to secure this itself within a framework set by Ofcom rather than for Ofcom to mandate interoperability. Accordingly, we propose to facilitate interoperability between existing and new multiplex operators at the request of the latter.

Question 20. Do you agree that we should facilitate interoperability between existing DTT multiplex operators and new operators using cleared spectrum?

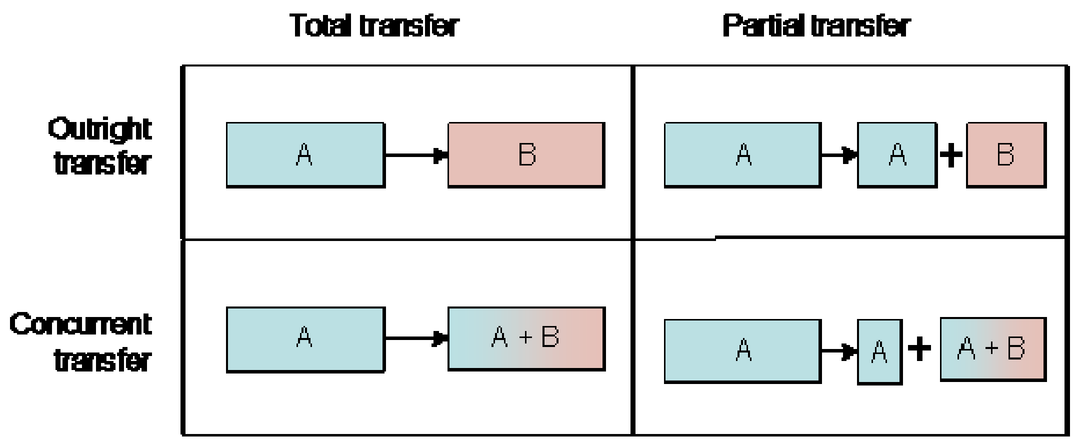
Spectrum trading

9.30 We began the implementation of spectrum trading for selected licence classes in 2004, through the Wireless Telegraphy (Spectrum Trading) Regulations 2004. The changes, described in the Spectrum Trading Statement, published in August 2004, introduced the possibility for licensees in specific classes to carry out:

- outright total transfers, i.e. transfers of all of the rights and obligations arising under a licence to a third party;
- concurrent total transfers, i.e. transfers of all of the rights and obligations arising under a licence to a third party which result in a concurrent holding of those rights and obligations by the transferor and the transferee(s);
- outright partial transfers, i.e. outright transfers of some of the rights and obligations arising under a licence to a third party; and
- concurrent partial transfers, i.e. transfers of some of the rights and obligations arising under a licence to a third party which results in a concurrent holding of those partial rights and obligations by the transferor and the transferee(s).

9.31 Figure 9.1 illustrates these four generic types of transfer.

Figure 9.1 Illustration of some possible types of transfer



Source: Spectrum Trading Guidance Notes - http://www.ofcom.org.uk/radiocomms/ifi/trading/tradingguide/

9.32 In the case of the licences for the geographic interleaved spectrum, we propose to amend the Wireless Telegraphy (Spectrum Trading) Regulations to allow all of the above types of transfer to occur for the licences awarded.

9.33 It should be noted that trading is not currently possible in Jersey (because Section 30 of the Wireless Telegraphy Act does not extend there) or Guernsey (because, while Section 30 of the Wireless Telegraphy Act does extend there, the Wireless

Telegraphy (Spectrum Trading) Regulations 2004 do not). We are talking to the authorities in both islands about their expressed interest in introducing trading, at least for licences for the spectrum subject to this award.

Licence commencement and duration

9.34 It was proposed in the Spectrum Framework Review: Implementation Plan[41] that new licences to be awarded by auction should generally have an indefinite term with a initial term. During the initial period the grounds for revocation would not include a general right to revoke for spectrum management reasons. After the end of the initial term, the grounds for revocation would include such a right, subject to a minimum notice period of five years. We also proposed that notice of revocation for spectrum management reasons could be given so that the licence ended the day after the expiry of the initial term.

9.35 The aim of these proposals was to provide licensees with a initial term during which they would have high security of tenure, and grounds for revocation would be limited to a narrowly defined set of conditions. The period of the initial term should be linked to a reasonable view of the period required efficiently to earn an appropriate return on the investment anticipated for efficient use(s) of the spectrum, and take into account any other factors that are relevant. The aim of proposing an indefinite duration was to give the licensee the opportunity to continue operating its business beyond the initial term. However, during this period we would be able to recover the spectrum by serving a notice of revocation in a similar manner to many other spectrum licences, if this step was justified on spectrum management grounds. In addition we would reserve the right to charge AIP in this period to incentive efficient use of the spectrum.

9.36 We consider that there are a number of reasons why licences with an indefinite term are likely to promote optimal use of the radio spectrum and other relevant objectives, including the promotion of competition.

9.37 In particular, the award of licences with an indefinite duration reduces the need for regulatory intervention to reassign spectrum at the end of the licence term. One disadvantage of fixed term licences is that at the end of the licence term the licence expires and so the rights to use it must be returned to the regulator, unless any other action has been taken. This may result in a period during which the spectrum remains unused as the regulator must go through a process to reassign those rights. Furthermore, incentives to invest closer to the end of a licence term are significantly reduced given that communications networks generally require continual investment. This lack of investment could result in detriment to consumers and citizens. The alternative of licences with an indefinite duration removes the requirement for return to the regulator, removes the risk of discouraging investment and creates additional opportunities for the market to secure the efficient use of the spectrum, particularly in the presence of spectrum trading.

9.38 We consider that, as a matter of principle, it is preferable to look to market mechanisms to promote the efficient use of resources rather than regulatory intervention, unless the case for such intervention is clear. To date we have not identified a general need for us to recover spectrum at the end of the initial term in relation to any of our spectrum awards.

[41] *Spectrum Framework Review: Implementation Plan. This document consults on the release of spectrum in 2005 – 08, and on extending spectrum liberalisation and trading to mobile services*, Ofcom, 13 January 2005, http://www.ofcom.org.uk/consult/condocs/sfrip/sfip/

9.39 We consider that there are likely to be a number of other advantages to adopting the general approach proposed above. In particular, reassignment by the regulator typically takes significant time and resource. The spectrum may also lie idle for a period as the regulator prepares for reassignment. While it may be possible to reduce this problem through the use of overlay auctions, the approach of an indefinite term together with spectrum trading seem likely to offer a simpler and less costly way of ensuring the spectrum is used efficiently.

9.40 We therefore favour offering licences with an indefinite duration for the cleared spectrum. The retention of powers to revoke on spectrum management grounds provides a mechanism allowing regulatory intervention if this is justified in particular cases

9.41 The inclusion of an initial term in the licence is desirable in order to give sufficient certainty to investors to incur the necessary costs to put the spectrum into use. Without an initial term there is a risk that this may not occur and so the spectrum would not be used efficiently.

9.42 Consistent with the above general policy framework, we propose to take the following approach in respect of duration for licences issued for spectrum subject to this award:

- the licences to have an indefinite duration;
- the licences to have a initial term of a specified duration, as discussed below;
- we will be able to revoke the licences before the expiry of the initial term on the limited grounds set out below; and
- we will be able to revoke the licences from any point after the expiry of the initial term on the grounds set out below, but also for spectrum management reasons subject to us giving five years notice; it will be possible for us to give notice of revocation during the initial term, for revocation to take effect after expiry of the initial term.

Rights to revoke licences during the initial term

9.43 The initial term is designed to provide licensees with a high security of tenure for investment planning purposes. During that period, we will not be able to revoke licences for spectrum management reasons and will only be able to do so in the particular circumstances described below.

9.44 During this initial term the licence may only be revoked for the following reasons:

- with the consent of the licensee;
- for non-payment or late payment of the relevant licence fee;
- if there has been a breach of any of the terms of the licence;
- if the licensee has not complied with any requirement of any relevant trading regulations;
- if the licensee has not complied with the auction regulations under which the licence was awarded, including any financial provisions including guarantees;

- we may at any time, by notice in writing, revoke or vary licence terms if it appears to us to be requisite or necessary or expedient to do so in the interests of national security, or for the purposes of complying with a Community obligation of the UK or with any international agreement or arrangements to which the UK is party; and

- if it appears requisite or necessary or expedient to do so for the purpose of complying with a Direction by the Secretary of State under Section 5 or Section 156 of the Communications Act.

Additional powers after the initial term

9.45 When the initial term has expired, the licence will remain in force and continue to be held by the licensee. Two additional conditions would then also apply:

- one relating to additional licence fees that we expect to be payable after the end of the initial term; and

- one providing an additional power to allow us to revoke or vary the licence on spectrum management grounds.

9.46 We consider these in turn below, addressing first the position in relation to fees after the initial term, and then the power to revoke on spectrum management grounds.

9.47 Our expectation is that, after the end of the initial term, licensees who wish to hold the licences issued under this award will need to pay additional licence fees. The level of these fees will depend on our general approach to fees for the use of spectrum at the time, and how that general approach relates to these licences and to our statutory duties at the time. The level of the fees cannot therefore be determined now. However, our expectation is that it will be appropriate to set fees based on Administered Incentive Pricing (AIP). The reasons for this are explained in more detail below. We also expect fees, as a minimum, to be sufficient to make an appropriate contribution to the costs of regulation.

9.48 AIP presently plays an important role in incentivising the efficient use of spectrum, and is widely applied to licences to use spectrum. Indeed, we have recently stated our intention to extend AIP to certain types of spectrum use that do not presently face AIP (such as terrestrial broadcasting and certain aeronautical and maritime uses). We have also stated that, in general, we expect to continue to apply AIP to licences after they have been made tradable, and that AIP may also be applied to licences that have been auctioned by us, after the end of the initial term. This is because the application of AIP is likely to promote efficient use of the spectrum, by sending very clear and tangible signals to users about the opportunity costs of using spectrum.

9.49 In relation to the licences that are the subject of this award, our view is that the application of AIP after the end of the initial term is likely to help secure the efficient use of the spectrum in the long term. This is because the application of AIP should be a complement to other policies designed to secure efficient use of the spectrum, notably the policies of awarding the spectrum by auction, and of making the spectrum licences tradable and liberalised. We consider that the advantages of applying AIP after the initial term are likely to outweigh any disadvantages, provided AIP is set at a level that is unlikely to deter efficient use.

9.50 We have taken account of the importance of the spectrum that is the subject of this award in considering this matter, and its usefulness. It is important to note that we would expect to give prior notice of our specific proposals to charge fees, and to consult as appropriate, before fees are introduced.

9.51 We also consider that it is appropriate for us to have wider powers to revoke or vary the licences that are the subject of this award after the end of the initial term. This reflects the greater uncertainty that will exist in the more distant future about the conditions that will make for optimum use of spectrum. We consider that market mechanisms should promote efficient use of spectrum, and be much more successful in this respect than widespread reliance on regulatory controls. The tradability and liberalisation of spectrum are key elements of a market-based approach. However, there may be circumstances in which additional intervention is justified in the public interest (for example, to overcome a specific market failure such as problems of co-ordination caused by high transaction costs).

9.52 We consider that it is in the public interest for us to have a greater power to take regulatory action, if justified, in relation to the use of the spectrum in the long term. This can be achieved by having an additional power to revoke or vary the licence on spectrum management grounds after the end of the initial term.

Duration of the initial term

9.53 As mentioned above, the initial term should be linked to a reasonable view of the period required to efficiently earn an appropriate return on the investment anticipated for efficient use(s) of the spectrum. We have considered the relevant period that might provide a reasonable chance for the businesses that might be most likely to operate in the bands to make an appropriate return on efficient investment without unnecessary regulatory risk.

9.54 Analysis already undertaken in connection with previous awards and our December 2007 Statement suggests that the minimum operational term of a licence supporting substantial new investment in a network would need to be in the region of 15 years. This approach was used in our 10-40GHz and L Band Awards. This is also in the middle of the range suggested by broadcasters in response to our December 2006 Consultation. Without a degree of certainty that they will be able to offer services for at least this sort of period of time, licensees are unlikely to be willing to make the investments necessary to efficiently exploit this spectrum.

9.55 At the same time use of the geographic interleaved digital dividend spectrum will not be possible on a UK-wide basis until 2012, with for example use in London not being possible before then. If such licensees are to have a reasonable prospect of earning a commercial return on their investments they will therefore need a reasonable degree of certainty that they will be able to continue offering service through to around 2027.

9.56 We also consider that there are a number of factors which are relevant to determining the initial term. The first of which is three of the existing DTT multiplex licences, if renewed, will reach the end of their renewed term in 2026 (12 years from 2014). We think there is merit in synchronising the end of the initial term for the new licences to be awarded for the digital dividend spectrum with the end of the renewed term for these existing DTT multiplexes which could enable a comprehensive assessment of the efficient use of the UHF spectrum at that time.

9.57 The majority of respondents to the December 2006 DDR consultation agreed with our proposal on linking the initial term with the expiry date of the three existing multiplexes.

9.58 We therefore propose that the initial term for the new licences to be awarded for the digital dividend spectrum should end in 2026.

9.59 We propose that the rights to the geographic interleaved spectrum should be available from completion of DSO in each region. We have no reason to suppose that DSO will be delayed. However if a delay does occur this will lead to a corresponding delay in the date from which the new rights to use of this spectrum can take effect.

Non-technical restrictions on use

9.60 In the light of our intention that the digital dividend be available on a service- and technology-neutral basis, we do not propose to impose any non-technical restrictions on the use to which the spectrum could be put in the licences (such as specifying the service that could be offered, the technology that could be deployed or the equipment that could be used).

Service obligations

9.61 Section 10 and Annex 12 discusses the appropriateness of 'use it or lose it' conditions and roll out obligations. For reasons explained there we do not propose to impose either of those obligations in this award. This is consistent with our general policy statements[42], which explain that such conditions are unlikely to be justified as a means to promote optimal use of the spectrum, which would instead be better achieved through other market-based mechanisms such as a competitive award process, spectrum trading, liberalisation and spectrum pricing.

Provision of information to facilitate optimal spectrum use.

9.62 In line with our duty to manage the spectrum efficiently, we propose to include a standard condition in the licences for the geographic interleaved spectrum to require licensees to provide us on request with general information regarding their equipment and use of frequencies, or the roll-out of their network. From time to time, we may publish aggregated information received on the number of base stations and frequency use in area across the UK, in order to help secure optimal use of the spectrum and facilitate trading, by helping interested parties who do not have access to this spectrum to identify areas where they may provide additional services by trading with licensees in that band.

9.63 We consider that this approach is objectively justified to fulfil our statutory duties and objectives, transparent, proportionate and does not discriminate between licensees.

9.64 We are currently investigating the type and scope of information that it would be useful to provide for this purpose. Therefore, we are particularly interested in the views of stakeholders on what information they think would help to facilitate efficient use of spectrum and secondary trading, and on the impact of the disclosure of this information might have on licence holders. In this respect there are a number of relevant considerations to bear in mind:

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[42] *Spectrum Framework Review: Implementation Plan. This document consults on the release of spectrum in 2005 – 08, and on extending spectrum liberalisation and trading to mobile services*, Ofcom, 13 January 2005, http://www.ofcom.org.uk/consult/condocs/sfrip/sfip/sfr-plan.pdf

- The extent to which information provided might fall under the scope of the Environmental Information Regulations;
- The ways in which spectrum usage and spectrum assignments can be compared, in order to identify unused spectrum in a meaningful way to external stakeholders (particularly in comparing cleared and interleaved spectrum usage);
- The wide variety of potential uses of the spectrum concerned, each of which might require different types of transmission network and use different business models to define affected customer bases (e.g. free-to-view broadcast transmissions versus subscriber-based business models);
- The restrictions that might need to be placed on published information to preserve as far as possible appropriate commercial confidentiality and satisfactorily address security concerns;
- The balance which needs to be struck between information which is specific to the digital dividend spectrum and (potentially more limited) information that is comparable across a wider range of bands; and
- The benefits of providing users with as much useful information as possible versus the costs and risks of users providing data, and our aggregating and presenting data in particular formats (e.g. to enable ready geographic comparison of usage and allocation data in particular frequencies).

9.65 In relation to the latter two considerations, we are currently examining the issue of spectrum information provision more widely and plan to publish consultation proposals later this year. However, we will be able to take account of responses to this consultation in developing our more general proposals.

Question 21. We welcome views on the merits of the proposed approach to information provision; in particular concerning the type of information that may be helpful and any impacts that publication of information might have both on licence holders and the wider spectrum market.

Conclusions

9.66 The main specific non-technical conditions that we are currently proposing to include in the WTA licences to be issued as a result of the geographic interleaved spectrum awards are:

- licence term – indefinite, with a initial term lasting to 2026 during which we will have limited rights of revocation;
- provisions for us to revoke licence on spectrum management grounds on any date after expiry of the initial term, subject to 5 years' notice and to apply AIP after expiry of the initial term if appropriate;
- tradability – the licences to be tradable; all legal forms of trading to be permitted;
- a standard licence condition requiring licensees to provide us on request general information regarding their equipment and use of frequencies, or roll out of their network;

- ownership restrictions – local authorities, political bodies, religious bodies, and bodies exerting undue influence will not be permitted to hold licences;

- non-technical restrictions on use – the licences to not restrict the service to be offered or the technology or type of equipment to be used (other than the minimum technical restrictions necessary to control harmful interference); and

- the licences will not contain roll-out obligations or ‘use-it-or-lose-it’ conditions.

Section 10

Promoting competition and efficiency

Introduction and summary

10.1 The DDR statement noted that it would be necessary to consider how awarding this spectrum could best promote competition and efficiency in downstream markets. This section sets out our approach to this assessment, and our proposals for how to ensure that competition and efficiency are best promoted through the award and use of the geographic interleaved spectrum.

10.2 Our recent consultation document concerning the award of the cleared spectrum made a similar assessment of competition and efficiency issues in respect of that spectrum. Given that the geographic interleaved spectrum concerns similar frequency ranges and in principle many (but not all) of the same potential uses of the spectrum, our analysis in this section and Annex 12 is consistent with our analysis in section 9 of that consultation document. Nevertheless our assessment of competition and efficiency issues here in respect of the geographic interleaved spectrum is intended to be readable without reference to our cleared consultation document, and provides references and summary material where applicable.

10.3 Our proposals reflect our belief that the geographic interleaved spectrum provides an important opportunity for the introduction of new services in the UK. This spectrum is valuable because of its position at around 1GHz, combining the benefits of both range (propagation) and capacity (bandwidth) that makes it suitable for many different uses. However, while it is clear that this spectrum is valuable, when considering the significance of competition and efficiency issues it is important to recognise that it is likely to be of lesser value than the spectrum in the cleared award. This is for two reasons. Firstly, compared to the cleared spectrum, the nature of geographic interleaved spectrum means that the use of this spectrum may be less versatile than spectrum offered in the cleared award. This is in part because it is a patchwork of frequencies across a number of geographic locations. Secondly, in each location we are proposing to auction perhaps 8 MHz to 16 MHz compared to 128 MHz to be made available via the cleared award.

10.4 Nevertheless, as set out in sections 4 and 5, this spectrum can form the building blocks for a number of services (such as, but not limited to, local and regional broadcasting) which are potentially of significant value to UK citizens and consumers. Our approach to its award can influence the market structure which emerges as a result of the award. Generally, the more competitive the market structure, the lower the level of market power held by firms in the market, and as a result the more competition and efficiency are promoted. Hence, it is important for us to take particular care to ensure that our approach achieves these goals. As explained below, the promotion of competition and efficiency is important for ensuring that total value to society is fully realised.

10.5 Because of this, promoting competition and efficiency are always important considerations when we are awarding spectrum, and more generally in our approach to spectrum management. The link between competition and efficiency considerations and our duties is set out in section 3. In addition, these and other duties which are relevant to our spectrum management activities are discussed in the Spectrum Framework Review[43].

10.6 In this section we explain:

- why we think competition and efficiency are important for promoting citizen and consumer value from the use of spectrum;
- how our approach to awarding and managing spectrum is designed to promote both competition and efficiency;
- how this approach should be applied in the context of the geographic interleaved awards, this includes consideration of whether there are specific risks of market failure (which through their impact on market structure would impact on the promotion of competition and/or efficiency) that might require us to take tailored action in relation to any particular potential use of the geographic interleaved spectrum.

10.7 The key conclusions reached in this section are set out in the following paragraphs.

10.8 We believe that the first step in promoting competition and efficiency in the geographic interleaved awards should be through the design of the spectrum awards. This includes for example, using auction design and packaging to help to promote a market structure which furthers competition and efficiency, for example, by enabling entry by new operators (where this is efficient) and by reducing as far as possible asymmetries between bidders which might unduly impact upon their ability to reflect their demand for spectrum.

10.9 We have considered whether there may be a case for us to go beyond this to promote competition and efficiency either by putting in place general safeguards or by intervening to resolve significant risks of market failure which could impact on the market structure which emerges as a result of the award. When considering the case for such intervention we need to pay attention to the costs and benefits of intervention, including the risk of regulatory failure (i.e. the costs imposed if the intervention has unintended consequences) and also take into account that, after the award of spectrum, we retain the ability to resolve significant competition concerns which emerge in downstream markets through our sectoral and competition powers.

10.10 In relation to any general safeguards, we identified that the following provision might be appropriate given the importance of the spectrum:

- An information provision licence condition which would help reduce information asymmetries between spectrum users and help to facilitate an efficient secondary market. This information provision is discussed below and in section 9.

10.11 In order to identify whether there are specific issues in relation to individual potential uses of the geographic interleaved spectrum which could result in a significant risk of market failure, we have examined the potential uses of the geographic interleaved spectrum, and the potential for their acquisition of spectrum to result in a market structure in which competition and efficiency are not promoted. This analysis has identified a number of potential market failure issues.

[43] See http://www.ofcom.org.uk/consult/condocs/sfr/sfr/sfr_statement

10.12 However, our initial view is that these issues do not require action in the award of the geographic interleaved spectrum as the issues are either not sufficiently significant to warrant action (given the costs and risks of intervention on efficient spectrum use), or (if they emerge as significant issues) are better resolved through other forms of intervention.

10.13 In summary, it is important that the geographic interleaved awards promote both competition and efficiency in the award and use of this spectrum. We believe that our award processes will go a long way towards this. We consider in the remainder of this section whether there is a case for us to go further in terms of putting in place general safeguards or other specific interventions to secure these goals. We conclude that one general intervention may be appropriate; this is an information provision licence condition that will help facilitate an efficient secondary market. We are particularly interested in views from stakeholders regarding our approach either in general or in relation to the specific issues considered in this section.

Why competition and efficiency are important

10.14 Spectrum is a very valuable resource and is a key input to a wide variety of services. In aggregate spectrum underpins around £37 billion of UK economic activity, equivalent to around 3 per cent of UK annual economic output[44]. It supports a number of services which are of value to society, including mobile communications and broadcasting. Spectrum is likely to remain an important input to these kinds of services in the future and innovation and technological development of services are likely to see the demand for spectrum enhanced.

10.15 Promoting competition through the use of spectrum is important as consumers are likely to benefit through lower prices, and/or higher service quality and innovation where services are provided in a more competitive environment (i.e. where individual players hold less market power). As spectrum is a key input to the provision of many important communications services a more competitive market structure for the provision of these services will be fostered where spectrum is available to service providers in a competitive manner. Auctions for spectrum in the UK have in general facilitated more competitive market structures by, among other things, encouraging new entry.

10.16 Promoting efficiency through the award and use of spectrum is important as citizens and consumers will benefit where spectrum is used efficiently. Given the value of services which are dependent on spectrum, not to use spectrum efficiently would risk depriving citizens and consumers of services that might otherwise have been provided, and could potentially impede UK productivity and economic growth. Inefficient spectrum use could include a service provider not fully using all of the spectrum they have acquired and not trading any leftover spectrum with others who could make better use of it, either because they fail to recognise this opportunity or because of undue difficulties in trading.

10.17 The promotion of competition and efficiency are to some extent linked. Competition in the provision of services will tend to promote efficiency in downstream markets by giving operators incentives to innovate and to provide services more cost effectively, for example by ensuring that the minimum amount of spectrum is used to produce the desired level of output. In some situations there may be a trade off between competition and efficiency, for example, when a market is already relatively competitive it can sometimes be the case that additional entry is inefficient. This can

[44] See http://www.ofcom.org.uk/research/radiocomms/reports/economic_spectrum_use/

happen when entry results in additional fixed costs which outweigh the competition benefits of entry (as these tend to decline the more firms in the market). However, in the majority of cases, promoting competition will also promote efficiency.

Three step approach to promoting competition and efficiency in the geographic interleaved awards

10.18 The introduction of a market led approach to spectrum management is motivated by our desire to improve efficiency and competition both in the spectrum market itself and in markets for services reliant on spectrum.

10.19 A market led approach to spectrum management helps to promote competition and efficiency since, when markets work well, they help to reveal information and provide incentives which promote efficiency. Additionally, a market led approach can help to reduce barriers to entry by reducing restrictions on spectrum use which helps to make spectrum more substitutable, and so promotes more competitive market structures by making new entry easier.

10.20 However, these features of a well functioning market will not always emerge. This is because markets sometimes fail. There are a variety of market failures which can arise when spectrum is managed through a market led approach, and it is important for us to take these into account, as it is possible to reduce the risk of market failure by adapting the approach to reflect these risks.

10.21 Examples of potential market failures which could have a significant impact upon whether a market led approach promotes competition and efficiency are provided below:

- In some situations it is possible for the holding of spectrum in particular frequency ranges to be crucial for the provision of goods or services in a particular downstream market. Where holding of this spectrum is concentrated in a few hands, competitors may be impeded from entering the market for the downstream services, and so the resulting market structure is one in which competition is not promoted fully. The potential competitive advantages of spectrum holding in this situation, owing to the barrier to entry it represents, may provide a motivation for a party to acquire and hoard spectrum, with the intention purely of denying its use to others, and hence preventing the emergence of a more competitive market structure. These incentives can arise even if the market is not characterised by single or collective dominance (under the tests defined in competition law), but the risk of such behaviour is likely to diminish the more competitive the market and hence the less the market power held by individual market players.

- Secondary trading of spectrum is an important mechanism for parties to optimise their spectrum holding and use patterns according to market circumstances and in response to technological developments. However, the emergence of efficient spectrum trading depends on the extent to which both current and prospective spectrum owners have relevant information about spectrum in the market and the uses to which it is being or can be put. A lack of relevant publicly available information can result in a market failure which impacts on spectrum efficiency because it impedes price formation, spectrum acquisition and hence efficient spectrum use.

10.22 In considering our proposals for the cleared and the geographic interleaved awards we have used a three step approach to reducing the risk of market failure. The first step involves using auction design and packaging to try and set the foundations for a well functioning market, and to bring about (where relevant) a market structure that furthers competition. The next two steps in the process involve considering whether or not to impose varying forms of regulatory intervention, to reflect the risk that, given the nature of the spectrum and its uses, it may not be possible to achieve a well functioning market through appropriate award design alone. In summary, the three steps can be described as follows:

- The first step involves using auction design and packaging to promote competition and efficiency. For example, the auction can be designed in order to help to reveal information which can minimise the ability of participants to behave strategically to manipulate the outcome of the award process. This step can often go a long way towards achieving an outcome where a well functioning market, with a market structure that furthers competition, emerges without imposing significant costs on participants. This is because this approach generally works by removing barriers that may prevent the market from working, but does not involve substituting regulatory decisions for the outcome of the market. However, in some situations, for example, when the spectrum under consideration is particularly valuable and there are limited substitutes, these provisions alone may not be enough to ensure that a well functioning market emerges.

- The second step involves considering whether there is a need for general safeguards to provide spectrum holders with sharper incentives to use spectrum efficiently and to promote competition through bringing about a more competitive market structure. These safeguards would apply to all spectrum holders irrespective of the use to which they put the spectrum. These remedies would generally involve imposing regulatory judgement on the outcome of a market and can impose significant costs if this judgement proved to be incorrect. As a result, we need to consider the costs and benefits of these interventions carefully before deciding to act.

- The third step involves identifying whether there are potential uses to which spectrum could be put which raise specific market failure risks, and identifying whether targeting intervention designed to help to ensure that the award brings about a more competitive market structure would be an appropriate regulatory response to such risks. As with the general remedies mentioned under step two above, remedies imposed to forestall or alter such risks impose regulatory judgement on the outcome of a market, and hence it is important to consider the costs and risks involved to ensure that these do not outweigh the likely benefits of intervention.

10.23 If these steps are either insufficient to remedy any problem, or if, owing to uncertainty over the market outcome, the costs of pre-emptive intervention are too high to justify action, we have general sectoral and competition powers that enable us to address certain competition concerns if they emerge.

10.24 As we discussed earlier, we have a principal duty to promote competition where appropriate, which is a related but nevertheless separate concept to addressing anti-competitive behaviour where it occurs. Our spectrum awards to date have illustrated how auctions can promote competition through allowing new entry and bringing about more competitive market structures. This is one reason why we are potentially concerned about situations where the presence of some level of market power (even in cases where this level of power is below that which would imply dominance) may create the conditions for the award of spectrum (absent intervention) to fail to bring about more competitive market structures. Hence, in summary, given our duty to promote competition, we are concerned by award outcomes where the likely market structures are less competitive compared with what they were or could have been under different award outcomes. And where these likely market structures result in market players having a degree of market power (even though this does not in itself suggest that a dominant position and anti-competitive behaviour will emerge).

10.25 In the 2006 DDR consultation document and 2007 DDR statement we carefully considered the risk of the award of the digital dividend resulting in a market failure which might suggest the need for us to depart from a market led approach, and identified an analytical approach for assessing these issues. This analytical approach involves identifying and trading off the benefits of resolving the market failure with the costs of the intervention and the risks of regulatory failure. In this section we apply this framework to assess the potential for market failures which could impact upon whether the use of the geographic interleaved spectrum assigned through auction promotes competition and efficiency. This does not mean that we are re-opening our assessment of whether a market led approach is the best way to maximise the total value to society generated by the use of the spectrum over time, but recognises that in facilitating markets (i.e. through our auction design) we face choices which impact upon the likelihood of these markets achieving a successful outcome that promotes competition and efficiency, for example, by helping to ensure that (where possible) more competitive market structures emerge.

10.26 In the remainder of this section we apply each of the three steps set out above to the geographic interleaved awards to identify how best to promote competition and efficiency through these awards.

Question 22. Do you agree with our approach to assessing whether the awards of geographic interleaved spectrum fully promote competition and efficiency?

Question 23. Do you have particular concerns about possibilities for award outcomes to fail to fully promote competition in downstream markets or to result in inefficient use of spectrum? If so, please explain what these are and provide supporting evidence.

Step one - using packaging and auction design to promote competition and efficiency

10.27 We consider next how decisions over packaging and auction design can help to create the foundations for a well functioning market that supports the development of competition, and hence, promotes competition and efficiency. We have taken the conclusions of this analysis into account in sections 6 and 7.

10.28 In relation to packaging, we considered how this can impact upon possible outcomes of the award process and the consequences for competitive market structures both in the spectrum market itself and associated downstream markets. There are a number of ways in which our packaging proposals promote competition and efficiency, for example:

- We can package the spectrum into sufficiently small units such that interest in participating in the auction is maintained for all bidders.

- We can package the geographic interleaved spectrum such that it can support a variety of uses.

- We can maximize opportunities for bidders to aggregate or substitute lots, or to put spectrum to different downstream uses, by packaging frequency channels separately for any one transmitter.

10.29 In relation to auction design there are a variety of ways in which this can be used to promote competition and efficiency, for example by:

- maximising the incentives on participants to bid their true value for the spectrum;
- minimising incentives and possibilities for strategic behaviour by bidders aimed at excluding other bidders or reducing prices paid; and
- maximising opportunities to participate and hence facilitate efficient new entry (e.g. by phasing the auctions).

10.30 We have taken these into account in identifying our proposed auction format for the first phase of the geographic interleaved spectrum award – an ascending bid auction – which includes a number of relevant features designed to assist in the efficient allocation of spectrum and encourage competitive entry. These features are set out in the discussion of the auction rules in section 7 and include:

- The use of a second price rule which encourages bidders to bid their true value for spectrum, because they can be sure that if this is a winning bid, they will have obtained an asset with some level of value to them (equal to their bid less the next highest bid). If bidders were not to bid their true values but instead to shade their bids below their true value, this would risk inefficient outcomes.
- Rules on bidder association aimed at prohibiting collusive coalitions of bidders, or collusion concerning the bidding process itself.
- The extent to which information about bidders and bids is revealed throughout the auction process. These rules can aid price discovery, by addressing common value uncertainty. However, if too much information is revealed this can increase the risks of collusion or inappropriate tactical bidding or influencing.
- Participation rules and payment processes that aim to enable a wide participation in the award.

10.31 Our initial views concerning the auction format for the combined award also take into account the need to promote competition and efficiency. There is for an example an explicit need to take into account aggregation risk and allow all bidders to express their interest in buying lots either for aggregation or on standalone basis. Our view that a CCA format is preferable rests to a significant extent on this need.

10.32 We will also take the promotion of competition and efficiency into account when proposing appropriate auction proposals for final phase of awards.

10.33 In summary, we think these proposals and intended approach will go a long way towards fostering competition and efficiency in the geographic interleaved award. However, in the remainder of this section we go on to consider whether further regulatory action may be required.

Step two - general provisions to promote competition and efficiency

10.34 In this section we consider whether there may be a case for general regulatory remedies to promote further competition and efficiency. This section provides our conclusions on the application of general remedies to the geographic interleaved awards, the detail of our analysis is set out in Annex 12.

10.35 Any general remedies would apply to all of the potential uses of the geographic interleaved spectrum and would seek to sharpen the incentives of spectrum holders to use spectrum efficiently and to promote more competitive market structures. They would not therefore be made with reference to particular issues that might concern particular uses of the geographic interleaved spectrum; these are considered under our third step below.

10.36 We also note in this context that a number of respondents to the DDR consultation document raised questions around competition issues and some suggested potential general remedies. Taking these into account, we have considered and concluded on the application of the following general remedies in the geographic interleaved awards:

- Use it or lose it requirements – these would involve using licence conditions to ensure that spectrum licensees do not hold spectrum idle.

  We do not propose to introduce this remedy in the geographic interleaved awards. The key reason for this is because this remedy tends only to be effective where spectrum is demonstrably idle for inefficient reasons. Where these conditions are not met, this remedy risks forcing use of spectrum where it is not yet efficient to do so.

- Rollout obligations – these would ensure that spectrum holders rollout services to a certain minimum extent.

  We do not propose to introduce this remedy in the geographic interleaved awards. The key reasons for this are because, the market failure which rollout obligations are designed to resolve (i.e. socially sub-optimal levels of coverage), is not one which we think is likely to be a significant issue for the geographic interleaved spectrum, given how it is likely to be used. And because, even if this form of market failure were to occur, we think that rollout obligations are unlikely to be the best remedy for this. Direct funding can achieve the same benefits in a more cost effective manner.

- Information provisions – these would work to ensure that there is information available to the market on spectrum holdings, the aim of which is to remove potential barriers to efficient secondary markets.

  We see merits in this remedy since it tends to promote secondary trading, price formation, and hence efficient spectrum use. The disadvantages of such a remedy are relatively limited and primarily concern commercial confidentiality issues. We consider therefore that such a remedy could have general merit.

- Access requirements – these would involve placing conditions in licences that would require spectrum holders to provide access either to the spectrum they hold or to the networks they build using this spectrum in order to further remove barriers to entry, and promote more competitive structures in downstream markets.

We do not propose to introduce this remedy in the geographic interleaved awards. We do not think that there is a competition or efficiency issue which could be resolved by access requirements which applies across all of the likely uses of the geographic interleaved spectrum. Hence, the benefits of a general remedy are unclear. Additionally, this approach tends to be most effective where the spectrum uses to which access conditions might apply are reasonably well foreseen, although even here, access requirements must be carefully designed. Where the nature of the access issue is unclear or uncertain (as for the geographic interleaved spectrum) this remedy can be costly, as for example, there are significant risks of unintended consequences.

- Spectrum caps – these would involve placing limits on the amount of spectrum that any one licensee can hold. The purpose of this would be to ensure that spectrum holdings are not heavily concentrated (i.e. that the award does not result in a very small number of players holding all of the spectrum), and hence more competitive market structures are promoted.

  Remedies of this type can have general benefits in that they can promote diversity of spectrum holdings and so can help to facilitate secondary trading and market entry. However risks include that spectrum caps set too tightly prevent efficient entry and spectrum use in the first instance. Concerning the geographic interleaved spectrum, we consider that such risks will tend to outweigh any such benefits.

10.37 Annex 12 includes our detailed considerations for each of these remedies.

10.38 Overall we propose that, in respect of the geographic interleaved awards, it may be appropriate to introduce an information licence condition. This would require the provision of information related to spectrum holdings and use, with the intent of placing this in the public domain. It would be aimed at enabling existing and prospective spectrum holders to evaluate the potential uses and value of spectrum, and so promoting efficient price discovery, secondary trading, and efficient spectrum use. Section 9 discusses the issues affecting the detailed drafting of a general information provision licence condition, and seeks views.

10.39 We do not at this stage propose, for the reasons set out above and in Annex 12 to introduce any other general remedies.

10.40 We recall in this context that for the cleared award, we have proposed (along with an information provision licence condition) a general remedy of a safeguard spectrum cap of 50 MHz. For the reasons set out in Annex 12 we do not at this stage see a strong case for extending the scope of such a spectrum cap to include the award of geographic interleaved spectrum. We remain however open to views.

Summary of first two steps to promoting competition and efficiency in the geographic interleaved awards

10.41 Therefore in summary the first two steps in our approach to promoting competition and efficiency in the award and use of the geographic interleaved spectrum have resulted in the following conclusions:

- We are proposing to use auction design and packaging as the starting point for the promotion of competition and efficiency. Our proposals for packaging and auction design were set out in sections 6 and 7 respectively.

- We are also proposing an information provision licence condition which aims to put into the public domain information about spectrum holding and use in order to facilitate secondary trading. We have discussed the issues affecting the detailed drafting of such a condition in section 9.

- We are not proposing use it or lose it, rollout conditions, general access conditions, or a spectrum cap.

Question 24. Do you agree with our proposals to include an information provision licence condition to help facilitate efficient secondary trading?

Question 25. Do you agree with our view that we should not apply any general remedies other than for information provision in the geographic interleaved award?

10.42 In the next section we consider whether there are specific market failure risks which might require us to take tailored action in relation to any particular potential use of the geographic interleaved spectrum.

Step three - specific issues considered by the competition and efficiency assessment

10.43 We set out here the process we have followed in analysing and identifying particular competition and efficiency considerations that might arise as a result of particular outcomes of the geographic interleaved spectrum award which have the potential to result in market structures which could have been more competitive if we had intervened (i.e. which fail to fully promote competition). Where these situations are identified we think they merit specific consideration as they may require intervention above and beyond that given by packaging and auction design and the more general remedies discussed under steps 2 and 3 respectively.

10.44 Our analysis has focused on three broad downstream markets: broadcasting, mobile broadband, and mobile multimedia. As discussed in section 4, and in our earlier DDR documents, these encompass the most likely potential uses of the geographic interleaved spectrum.

10.45 For each broad downstream market, we considered a wide range of spectrum award outcomes in order to assess the likelihood and significance of market structures emerging, absent intervention, that may fail to fully promote competition, and the significance of such an outcome for consumers and the competitive process more generally.

10.46 Our assessment was forward looking and necessarily to some extent speculative. The three downstream markets considered are rapidly developing and subject to a considerable degree of uncertainty. Any intervention or remedy posited in order to promote more competitive market structures will carry its own risks and/or costs. This means that we need to be careful when identifying market structures which could in principle be more competitive and, when we do identify such outcomes, in proposing any remedies for them.

10.47 For this reason, our analysis has sought to focus on outcomes where the potential market structure could be more competitive, and where, if this were the case, consumer benefits could be significantly higher. In principle, where these outcomes occur, we would go on to consider whether there are available remedies which can promote more competitive market structures without imposing unreasonable costs, noting that we might be prepared to accept a higher cost or risk from a remedy where it is likely to promote a significantly more competitive market structure. We have also considered the extent to which competition considerations attached to certain spectrum award outcomes might better be addressed in ways other than intervening in the spectrum award itself.

10.48 In identifying outcomes where we could help to bring about a more competitive market structure if we were to intervene further, we have given particular attention to markets where we are aware of recent and/or ongoing analysis in relation to whether the current (or likely future) market structure is consistent with the promotion of competition.

10.49 The table below sets out the full set of issues we have considered (based on the potential uses and the likelihood of an outcome occurring which could in principle have an impact on market structure) and highlights two issues which we identified as sufficiently important to require consideration of whether there is a case for applying a remedy in the geographic interleaved award.

Table 10.1 Scenarios considered to identify outcomes when the market structure could be more competitive

Description of possible spectrum award outcome	Potential impact on market structure	Analysis
Broadcasting		
Sky purchase of geographic interleaved spectrum for aggregation into sub UK mux for pay TV services	- If Sky were found to have market power in premium pay TV and related markets, then this could create the potential for an acquisition by Sky of DDR spectrum to potentially foreclose the development of more competitive market structures, for example by limiting the ability of other competitors to access terrestrial broadcasting capacity	- The Pay TV market investigation consultation document[45] set out concerns regarding effective competition in the pay TV industry. Given this we think that we need to consider carefully the potential for Sky to acquire DDR spectrum in order to identify whether, because of Sky's market position, this could impact on the promotion of competition or efficiency as a result of the award of the geographic interleaved spectrum (i.e. whether this could result in a market structure which could be more competitive) - Therefore, **this issue is considered further below**
ITV acquisition and aggregation of geographic interleaved spectrum to deploy additional DTT multiplex(es)	- Could potentially allow ITV to strengthen its position in the national TV advertising market	- Given the presence of the Contract Rights Renewal (CRR) remedy, and given the current OFT/Ofcom review[46] of this remedy, **we do not think this issue is sufficiently significant to warrant consideration of separate action**

[45] See http://www.ofcom.org.uk/consult/condocs/market_invest_paytv
[46] See http://www.oft.gov.uk/advice_and_resources/resource_base/register-orders-undertakings/reviews/CRR-review

		in the award of the geographic interleaved spectrum
NGW/Arqiva acquire and aggregate geographic interleaved spectrum to deploy additional DTT multiplex(es)	- Spectrum acquisition could potentially result in a player with a greater degree of market power over the DTT multiplex capacity market in addition to market power over upstream services (i.e. managed transmission services) and as a result more competitive market structures may have been precluded	- We consider that this is an issue that requires careful consideration - Therefore, **this issue is considered further below**
PSBs (other than ITV) purchase and aggregate geographic interleaved spectrum to deploy additional DTT multiplex(es)	- Could increase their market share in terms of DTT capacity - Has the potential to exclude new entrants, and other downstream broadcasters, and hence fail to result in a more competitive market structure	- There is little evidence to suggest that the PSBs acquisition of geographic interleaved spectrum would preclude better market structures arising, and for this to have resulted in significantly lower benefits for consumers than would otherwise be the case - **We do not think this issue is sufficiently significant to warrant consideration of separate action in the award of the geographic interleaved spectrum**
Mobile broadband		
Geographic interleaved spectrum is purchased to provide or supplement 3G or Next Generation Mobile (NGM) network (i.e. LTE or WiMAX)	- The advantages of low frequency spectrum, combined with its limited availability for these services, limits the number of networks that can be deployed using these frequencies - As a result, the market structure which emerges may be one in which the acquirer(s) of the DDR spectrum suitable for mobile broadband have an enhanced market	- The characteristics of geographic interleaved spectrum mean that any broadband services deployed through it are more likely to be supplements to, rather than full substitutes for, mobile broadband services provided through DDR spectrum in general. Any acquisition of a significant portion of geographic interleaved spectrum for mobile broadband use is therefore unlikely to have a significant impact upon the market structure which emerges in the future mobile broadband market - **We do not think this issue is sufficiently significant to warrant consideration of separate action in the award of**

	position than other potential players in this market	**the geographic interleaved spectrum**
Mobile Multimedia Services (MMS)		
A Mobile Network Operator (MNO) (or a consortium of MNOs) purchases and aggregates geographic interleaved spectrum in order to provide network for own MMS service, or to provide a wholesale network service	- Potential to establish market structures which are less competitive than they could otherwise have been (i.e. could result in a vertically integrated monopoly in the provision of MMS services at either the retail or wholesale level, at least in short term);	- The availability of substitute spectrum and possibilities for consumers to access mobile broadcast and other content through other means (e.g. content download on 3G) means the market structure is unlikely to be determined by the outcome of the geographic interleaved award, and that sufficiently competitive market structures are relatively likely to emerge **- We do not think this issue is sufficiently significant to warrant consideration of separate action in the award of the geographic interleaved spectrum**
A broadcaster purchases and aggregates geographic interleaved spectrum in order to provide own use end-to-end MMS service	- Broadcaster control of content has the potential to allow a market structure to emerge in which competition is not fully promoted	
A broadcaster purchases and aggregates geographic interleaved spectrum in order to operate a network and to provide a wholesale network services to other MMS providers	- Broadcaster has the potential to establish a strong market position in the wholesale provision of MMS network services, and this precludes the development of more competitive market structures	

10.53 The high level summary of our assessment of possible spectrum award outcomes and the potential for these to result in market structures which could be more competitive highlights that, in most cases, we concluded that any concerns about the likely market structure were not sufficiently significant to warrant further consideration.

10.54 However, our assessment identified two particular issues for which we consider that there is sufficient potential for the market structure to be less competitive than it might otherwise have been. These are:

- Pay TV – Sky acquisition and aggregation of geographic interleaved spectrum for pay services on DTT; and

- NGW/Arqiva[47] – acquisition and aggregation of geographic interleaved spectrum for additional multiplexes on DTT.

10.55 We have considered further these two issues in order to identify whether targeted intervention in the geographic interleaved award may be warranted. Our full consideration of these issues is included in Annex 12. The following paragraphs summarise our considerations.

10.56 Regarding Sky, we have considered whether a potential acquisition of geographic interleaved spectrum by Sky in order to launch pay TV services on the DTT platform could result in a market structure which fails to fully promote competition. As discussed in Annex 12, within the last year we have published two consultation documents which have raised issues in relation to the potential for Sky to have market power[48], primarily in relation to the potential existence of any wholesale markets for premium content (likely to include first run Hollywood movies and particular types of sports content). If Sky does have has market power over wholesale markets for access to premium content, it is possible that an acquisition of geographic interleaved spectrum, coupled with control of premium content, could raise competition concerns around the potential to foreclose further development of competition in terrestrial broadcasting, and the potential to leverage any possible market power arising from control of premium content into retail markets across platforms. Both of these effects, were they to occur, could prevent the emergence of more competitive market structures. However, we recognise that any concerns arising from these are likely to be less than the concerns which may arise from a potential acquisition of cleared spectrum by Sky, given the more limited coverage afforded by geographic interleaved spectrum.

10.57 However, overall we see the question of access to premium content as the central issue in relation to the potential for there to be competition concerns arising in relation to Sky's market position. This issue is not primarily linked to the potential for Sky to acquire geographic interleaved spectrum, or to the impact this might have on market structure. This would suggest that any competition concerns are best pursued through our existing initiatives concerning Sky's 'Picnic' proposal and our wider review of the pay TV market. However, we recognise that we may need to keep this under review.

10.58 Regarding NGW/Arqiva, a scenario that could arise as a result of the geographic interleaved award is the acquisition by NGW/Arqiva of spectrum for use for one or more further commercial DTT multiplexes. This could in principle increase the share this entity has of the provision of multiplex services to commercial broadcasters from two out of three to three out of four or greater and so adversely affect parties seeking wholesale multiplex services. However, the likelihood and significance of adverse effects arising from such an outcome will tend to be ameliorated both by possibilities for such parties to find alternative carriage on other DTT multiplexes and or other broadcasting platforms, and by the fact that any such new multiplexes provided through geographic interleaved spectrum are likely to be constrained in coverage. Furthermore, we note that, if these were to raise competition concerns imposing remedies in the geographic interleaved award, such as a prohibition on the acquisition of spectrum, could risk a number of unintended consequences such as

[47] In April 2007, Arqiva's owner Macquarie UK Broadcast Ventures Limited acquired NGW. In this analysis we consider the impact of the merged entity acquiring geographic interleaved spectrum.
[48] These are firstly our Pay TV market investigation (see: http://www.ofcom.org.uk/consult/condocs/market_invest_paytv) and secondly, our assessment of Sky's 'Picnic' proposal (see: http://www.ofcom.org.uk/consult/condocs/dtv/)

the loss of opportunities the acquisition might afford for economies of scale or scope or missed opportunities to allow enhanced coordination abilities.

10.59 Hence, overall, taking into account the uncertainty over whether a competition concern would arise (i.e. whether a market structure which fails to fully promote competition could emerge) and the significant risks involved in seeking to remedy this in the geographic interleaved award, we take the view at this stage that we should not intervene in the award in relation to the potential for NGW/Arqiva to acquire geographic interleaved spectrum. As a separate issue, we note that in the case that any anti-competitive behaviour were to arise, we would be able to seek to resolve this through our regulatory or competition powers as appropriate.

Question 26. Do you agree with our initial assessment that we should not intervene in the geographic interleaved award to remedy any potential impact on competition resulting from the holding of geographic interleaved spectrum by either Sky or NGW/Arqiva?

Conclusions

10.60 In this section we have explained why it is important to consider the impact of the geographic interleaved award on competition and efficiency in downstream markets, and how our approach to the award aims at achieving this goal.

10.61 Our starting point for promoting competition and efficiency is to use the primary award process (i.e. packaging and auction design) to, for example, maximise the incentives on participants to bid their true value for the spectrum, minimise incentives and possibilities for strategic behaviour by bidders aimed at excluding other bidders or reducing prices paid, and maximise opportunities to participate and hence facilitate efficient new entry.

10.62 In addition, we have considered whether there is a case for general remedies which could further promote competition and efficiency. After considering the following remedies: use it or lose it requirements, rollout obligations, information provisions, access requirements, and spectrum caps, we have reached the initial view that in order to promote opportunities for secondary trading, and hence efficient spectrum use, we should facilitate the provision of information concerning spectrum holding and use by imposing an information provision licence condition.

10.63 We noted our proposal for a general safeguard spectrum cap of 50 MHz for the cleared award, as discussed in our June 2008 cleared award consultation document[49]. We do not at this stage see a strong case for extending the scope of such a spectrum cap in the cleared award to include the award of geographic interleaved spectrum.

10.64 We have also considered a number of specific market failure risks where we felt that the award outcome had the potential to result in a market structure which may not fully promote competition. These outcomes included:

- the potential for Sky to purchase and aggregate geographic interleaved spectrum to rollout a DTT multiplex and to use this to enter the terrestrial broadcasting market, and the potential for this to have a resulting impact on the emergence of more competition in broadcasting markets, and

[49] http://www.ofcom.org.uk/consult/condocs/clearedaward/

- the potential for NGW/Arqiva to purchase and aggregate geographic interleaved spectrum in order to rollout an additional DTT multiplex, and the potential for this to increase its share of the provision of wholesale multiplex services.

10.65 We do not however at this stage believe that the potential purchase of geographic interleaved spectrum by Sky or NGW/Arqiva, in order to operate one or more DTT multiplexes, raise issues that should be addressed through the geographic interleaved award.

Section 11

Next steps

11.1 This consultation, published on 12 June 2008, lasts for a 10-week period. The closing date for responses is 21 August 2008. See Annex 1 for details of how to respond to this consultation.

11.2 We are planning to hold a seminar on our proposals during the consultation period.

11.3 When the consultation has closed, we will undertake a comprehensive review of responses and factor this into our decision on the best way to progress the proposed awards. We will then confirm next steps.

The initial phased award

11.4 We are proposing that the initial phased award of lots for Caldbeck, Winter Hill and Wenvoe will take place in late 2008 or early 2009. We will finalise the details of the award in the light of responses to this consultation.

11.5 We will publish an Information Memorandum for the award. This will be designed to give bidders as much information as necessary for them to decide whether to enter the auction and how they would prepare for participation. It may be modified or complemented by the publication of updates and answers to specific questions.

11.6 Regulations will provide the legal basis for the auction and contain detailed and comprehensive rules and procedures for its running. The regulations are made by means of a statutory instrument. They must be published in draft with a minimum of 28 days allowed for comments. When all comments have been considered and necessary amendments made the regulations are made in final form; they come into force 21 days after being made.

11.7 Our provisional timetable suggests that both the Information Memorandum and the draft regulations should be published at the same time later in 2008.

The combined award

11.8 We are proposing a combined award of ‘large’ lots in the locations identified as being most suitable for aggregation. This award would take place soon after the award of the cleared spectrum, which is scheduled to begin in summer 2009.

11.9 The proposals for this award raise a number of issues, particularly in relation to the auction design discussed in section 7. Following our analysis of responses we expect to hold a further consultation on these issues later in 2008.

Further phased awards

11.10 We are proposing possible phased awards of ‘medium’ and ‘small’ lots in early 2010 and in early 2011, ahead of the latter stages of the DSO timetable, subject to evidence of demand. Following our analysis of responses to this we expect to hold a further consultation on these issues later in 2008.

Timetable for the awards

11.11 The table below sets out our current timetable for holding the geographic interleaved awards.

Table 11.1 Timetable for the geographic interleaved awards

Date	Activity
June 2008	First consultation on detailed award design
August 2008	First consultation closes
Early Autumn 2008	Information Memorandum and draft regulations for the initial phased award of medium lots for Carlisle, Cardiff and Manchester.
Late Autumn 2008	Second consultation on detailed award design for combined award. Second consultation on further phased awards.
Late 2008 or early 2009	Initial phased award. Second consultation closes
Late Spring 2009	Information Memorandum and draft regulations for combined award.
Autumn 2009	Combined award.
Early 2010	Phased award for medium and small lots
Early 2011	Phased award for medium and small lots

Annex 1

Responding to this consultation

How to respond

A1.1 Ofcom invites written views and comments on the issues raised in this document, to be made **by 5pm on 21 August 2008**.

A1.2 Ofcom strongly prefers to receive responses using the online web form at http://www.ofcom.org.uk/consult/condocs/ddrinterleaved/howtorespond/form, as this helps us to process the responses quickly and efficiently. We would also be grateful if you could assist us by completing a response cover sheet (see Annex 3), to indicate whether or not there are confidentiality issues. This response coversheet is incorporated into the online web form questionnaire.

A1.3 For larger consultation responses - particularly those with supporting charts, tables or other data - please email ddr.interleaved@ofcom.org.uk attaching your response in Microsoft Word format, together with a consultation response coversheet.

A1.4 Responses may alternatively be posted or faxed to the address below, marked with the title of the consultation.

DDR Geographic Interleaved Project Team
Spectrum Policy Group
Third floor
Riverside House
2A Southwark Bridge Road
London SE1 9HA

Fax: 020 7783 4303

A1.5 Note that we do not need a hard copy in addition to an electronic version. Ofcom will acknowledge receipt of responses if they are submitted using the online web form but not otherwise.

A1.6 It would be helpful if your response could include direct answers to the questions asked in this document, which are listed together at Annex 4. It would also help if you can explain why you hold your views and how Ofcom's proposals would impact on you.

Further information

A1.7 If you want to discuss the issues and questions raised in this consultation, or need advice on the appropriate form of response, please contact Joe Sonke on 020 7783 4345.

Confidentiality

A1.8 We believe it is important for everyone interested in an issue to see the views expressed by consultation respondents. We will therefore usually publish all responses on our website, www.ofcom.org.uk, ideally on receipt. If you think your response should be kept confidential, we ask you to specify what part or whether all of your response should be kept confidential, and to tell us why. If you wish parts of your response to be kept confidential, please place them in a separate annex to your response.

A1.9 If someone asks us to keep part or all of a response confidential, we will treat this request seriously and will try to respect this. But sometimes we will need to publish all responses, including those that are marked as confidential, in order to meet legal obligations.

A1.10 Please also note that copyright and all other intellectual property in responses will be assumed to be licensed to Ofcom to use. Ofcom's approach on intellectual property rights is explained further on its website at http://www.ofcom.org.uk/about/accoun/disclaimer/

Next steps

A1.11 Following the end of the consultation period, Ofcom intends to publish a statement in autumn 2008.

A1.12 Please note that you can register to receive free mail Updates alerting you to the publications of relevant Ofcom documents. For more details please see: http://www.ofcom.org.uk/static/subscribe/select_list.htm

Ofcom's consultation processes

A1.13 Ofcom seeks to ensure that responding to a consultation is easy as possible. For more information please see our consultation principles in Annex 2.

A1.14 If you have any comments or suggestions on how Ofcom conducts its consultations, please call our consultation helpdesk on 020 7981 3003 or e-mail us at consult@ofcom.org.uk . We would particularly welcome thoughts on how Ofcom could more effectively seek the views of those groups or individuals, such as small businesses or particular types of residential consumers, who are less likely to give their opinions through a formal consultation.

A1.15 If you would like to discuss these issues or Ofcom's consultation processes more generally you can alternatively contact Vicki Nash, Director Scotland, who is Ofcom's consultation champion:

Vicki Nash
Ofcom
Sutherland House
149 St. Vincent Street
Glasgow G2 5NW

Tel: 0141 229 7401
Fax: 0141 229 7433

Email vicki.nash@ofcom.org.uk

Annex 2

Ofcom's consultation principles

A2.1 Ofcom has published the following seven principles that it will follow for each public written consultation:

Before the consultation

A2.2 Where possible, we will hold informal talks with people and organisations before announcing a big consultation to find out whether we are thinking in the right direction. If we do not have enough time to do this, we will hold an open meeting to explain our proposals shortly after announcing the consultation.

During the consultation

A2.3 We will be clear about who we are consulting, why, on what questions and for how long.

A2.4 We will make the consultation document as short and simple as possible with a summary of no more than two pages. We will try to make it as easy as possible to give us a written response. If the consultation is complicated, we may provide a shortened Plain English Guide for smaller organisations or individuals who would otherwise not be able to spare the time to share their views.

A2.5 We will consult for up to 10 weeks depending on the potential impact of our proposals.

A2.6 A person within Ofcom will be in charge of making sure we follow our own guidelines and reach out to the largest number of people and organisations interested in the outcome of our decisions. Ofcom's 'Consultation Champion' will also be the main person to contact with views on the way we run our consultations.

A2.7 If we are not able to follow one of these principles, we will explain why.

After the consultation

A2.8 We think it is important for everyone interested in an issue to see the views of others during a consultation. We would usually publish all the responses we have received on our website. In our statement, we will give reasons for our decisions and will give an account of how the views of those concerned helped shape those decisions.

Annex 3

Consultation response cover sheet

A3.1 In the interests of transparency and good regulatory practice, we seek to publish all consultation responses in full on our website, www.ofcom.org.uk.

A3.2 We have produced a coversheet for responses (see below) and would be very grateful if you could send one with your response (this is incorporated into the online web form if you respond in this way). This will speed up our processing of responses, and help to maintain confidentiality where appropriate.

A3.3 The quality of consultation can be enhanced by publishing responses before the consultation period closes. In particular, this can help those individuals and organisations with limited resources or familiarity with the issues to respond in a more informed way. Therefore Ofcom would encourage respondents to complete their coversheet in a way that allows Ofcom to publish their responses upon receipt, rather than waiting until the consultation period has ended.

A3.4 We strongly prefer to receive responses via the online web form which incorporates the coversheet. If you are responding via email, post or fax you can download an electronic copy of this coversheet in Word or RTF format from the 'Consultations' section of our website at www.ofcom.org.uk/consult/.

A3.5 Please put any parts of your response you consider should be kept confidential in a separate annex to your response and include your reasons why this part of your response should not be published. This can include information such as your personal background and experience. If you want your name, address, other contact details, or job title to remain confidential, please provide them in your cover sheet only, so that we don't have to edit your response.

Cover sheet for response to an Ofcom consultation

BASIC DETAILS

Consultation title:

To (Ofcom contact):

Name of respondent:

Representing (self or organisation/s):

Address (if not received by email):

CONFIDENTIALITY

Please tick below what part of your response you consider is confidential, giving your reasons why

Nothing	☐	Name/contact details/job title	☐
Whole response	☐	Organisation	☐
Part of the response	☐	If there is no separate annex, which parts?	

If you want part of your response, your name or your organisation not to be published, can Ofcom still publish a reference to the contents of your response (including, for any confidential parts, a general summary that does not disclose the specific information or enable you to be identified)?

DECLARATION

I confirm that the correspondence supplied with this cover sheet is a formal consultation response that Ofcom can publish. However, in supplying this response, I understand that Ofcom may need to publish all responses, including those which are marked as confidential, in order to meet legal obligations. If I have sent my response by email, Ofcom can disregard any standard e-mail text about not disclosing email contents and attachments.

Ofcom seeks to publish responses on receipt. If your response is non-confidential (in whole or in part), and you would prefer us to publish your response only once the consultation has ended, please tick here. ☐

Name   Signed (if hard copy)

Annex 4

Consultation questions

Question 1. The executive summary sets out our proposals for the digital dividend geographic interleaved award. Do you agree with these proposals?

Question 2. Do you have any comments on our assessment of the most likely uses of the geographic interleaved lots? Are there any potential uses which should be considered that we have not mentioned?

Question 3. Are there any other types of DTT transmission that should be protected from potential cognitive devices or other factors that we should take into account?

Question 4. Are there any potential future PMSE applications, other than currently available wireless microphones, in-ear monitors and talkback systems, that you consider should be protected from potential cognitive devices?

Question 5. Is there sufficient evidence to require protection for other services such as mobile television, bearing in mind the potentially negative implications of such protection for deployment of cognitive devices?

Question 6. What levels of coverage and aggregation are of interest to you?

Question 7. Do you agree that the median option offers an acceptable balance between protecting reception of DTT services and maximising new DTT services using geographic interleaved lots?

Question 8. Do you agree with the proposal for a series of awards of spectrum lots - an award of lots for Caldbeck, Winter Hill and Wenvoe in late 2008 or early 2009, a single award in 2009 of large lots and awards of lots for other locations linked to DSO?

Question 9. Do you agree with the proposal to hold the combined award for large lots of geographic interleaved spectrum shortly after the cleared award in 2009? What should the time interval be?

Question 10. Do you agree with our approach to expressions of interest in order to finalise the spectrum lots appropriate to allocate by auction?

Question 11. Do you agree that we should run single unit ascending bid auctions for the award of each of the spectrum lots for Caldbeck, Winter Hill and Wenvoe?

Question 12. Do you have comments on whether the initial auctions of spectrum lots for Caldbeck, Winter Hill and Wenvoe should be run in sequence or in parallel?

Question 13. If the initial auctions are run in sequence do you have a preference for the order in which they run?

Question 14. Do you consider that a combinatorial clock auction would be more suitable than a simultaneous multiple round auction for the combined award of large lots suitable for aggregation?

Question 15. Do you agree with the proposal that the phased award of medium/small spectrum lots at locations linked to the DSO timetable should be by single unit ascending bid auctions? If not, which would be your preferred auction format and timing?

Question 16. Do you agree with the proposals for the main rules that we are minded to adopt for each of the three single unit ascending bid auctions?

Question 17. Do you have any comments on the technical licence conditions we are proposing to include in the licences?

Question 18. Do you agree that the licences for the geographic interleaved spectrum should not allow the co-ordination threshold to be exceeded?

Question 19. Do you agree that where the geographic interleaved spectrum is used for the operation of a DTT multiplex, we should replicate the ownership restrictions from the Broadcasting Act regime relating to (a) local authorities, (b) political bodies, (c) religious bodies and (d) bodies exerting undue influence but not replicate restrictions relating to (e) broadcasting bodies and (f) advertising agencies?

Question 20. Do you agree that we should facilitate interoperability between existing DTT multiplex operators and new operators using cleared spectrum?

Question 21. We welcome views on the merits of the proposed approach to information provision; in particular concerning the type of information that may be helpful and any impacts that publication of information might have both on licence holders and the wider spectrum market.

Question 22. Do you agree with our approach to assessing whether the awards of geographic interleaved spectrum fully promote competition and efficiency?

Question 23. Do you have particular concerns about possibilities for award outcomes to fail to fully promote competition in downstream markets or to result in inefficient use of spectrum? If so, please explain what these are and provide supporting evidence.

Question 24. Do you agree with our proposals to include an information provision licence condition to help facilitate efficient secondary trading?

Question 25. Do you agree with our view that we should not apply any general remedies other than for information provision in the geographic interleaved award?

Question 26. Do you agree with our initial assessment that we should not intervene in the geographic interleaved award to remedy any potential impact on competition resulting from the holding of geographic interleaved spectrum by either Sky or NGW/Arqiva?

Annex 5

Supplementary information on potential interleaved regional DTT coverage

A5.1 In this annex we examine, in more detail than section 5, the optimisation of interleaved spectrum in the nations and the impact on existing DTT services.

Optimisation of interleaved spectrum in the nations

A5.2 The main users of the interleaved spectrum are the existing DTT multiplexes. However there are still gaps, or white space, in the interleaved spectrum which could be used for additional services, as this consultation proposes. So far, all the work to identify potential lots for new services has assumed that the DSO frequency plan for the existing DTT multiplexes is fixed. But it is possible to change the DSO frequency plan (i.e. optimise the interleaved spectrum) to release more white space, whilst still meeting the DSO coverage targets. Ofcom commissioned NGW and Arqiva to look at potential optimisation of interleaved spectrum in Scotland and Northern Ireland respectively.

A5.3 Table A5.1 shows the number of main transmission sites and relay transmission sites, total households and land area for each nation to provide an indication of network scale.

Table A5.1 Statistics for the nations

Nation	Number of main transmission sites	Number of relay transmission sites	Total households	Area in km^2
England	28	642	23.0 million	130,427
NI	3	43	0.7 million	13,843
Scotland	13	226	2.5 million	78,772
Wales	6	200	1.4 million	20,778

Source: Ofcom

Scotland

A5.4 Compared with the rest of the UK, Scotland is more geographically remote from Ireland and Continental Europe. In addition, Scottish transmission sites have little interaction with UK sites in England, Wales and Northern Ireland. Consequently there is more interleaved spectrum available for use in Scotland than anywhere else in the UK.

A5.5 Even more interleaved spectrum could be made available in Scotland with some changes to the DSO frequency plan and international agreement to such changes. This was revealed by work carried out for us by NGW to assess whether the DSO plan in Scotland could be more efficient in its use of spectrum.

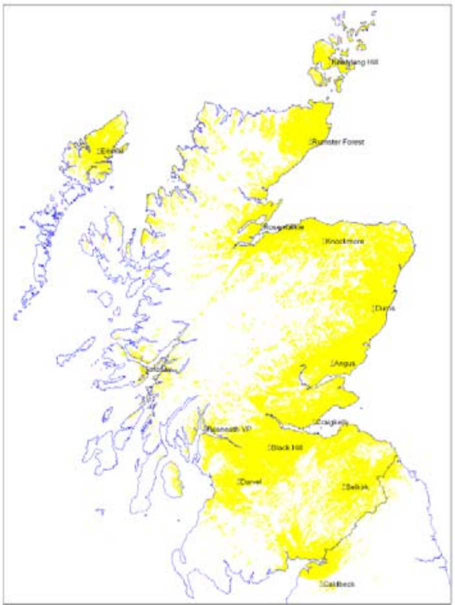
A5.6 NGW's study (which we are publishing with this report) indicates that five fewer channels (30, 48, 51, 52, 56) could be used for DSO in Scotland by revising the plan for one main transmission site (Rumster Forest) and nine relays. If these five channels were then used for two additional DTT multiplexes, coverage (assuming 64QAM) could be as shown in Table A5.2 and Figure A5.2. Note that these coverage predictions are just examples of what could be done. The five channels offer the potential for many different options, including more robust coverage by existing DTT multiplexes and the use of Single Frequency Networks ('SFNs').

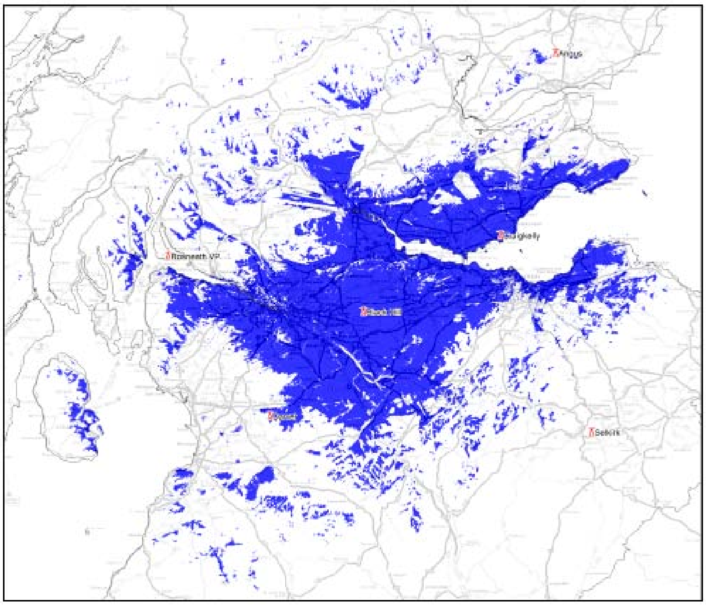
Table A5.2 Potential coverage by additional DTT multiplexes in Scotland

Multiplex	Coverage of Scotland (households)	Notes
First additional	84 per cent	Using network of 15 large transmission sites
Second additional	52 per cent	Using Black Hill and Craigkelly only (i.e. covers Glasgow and Edinburgh)

Source: Ofcom

Figure A5.1 Potential coverage by first (left) and second (right) additional DTT multiplexes in Scotland from optimisation of interleaved spectrum





Source: NGW

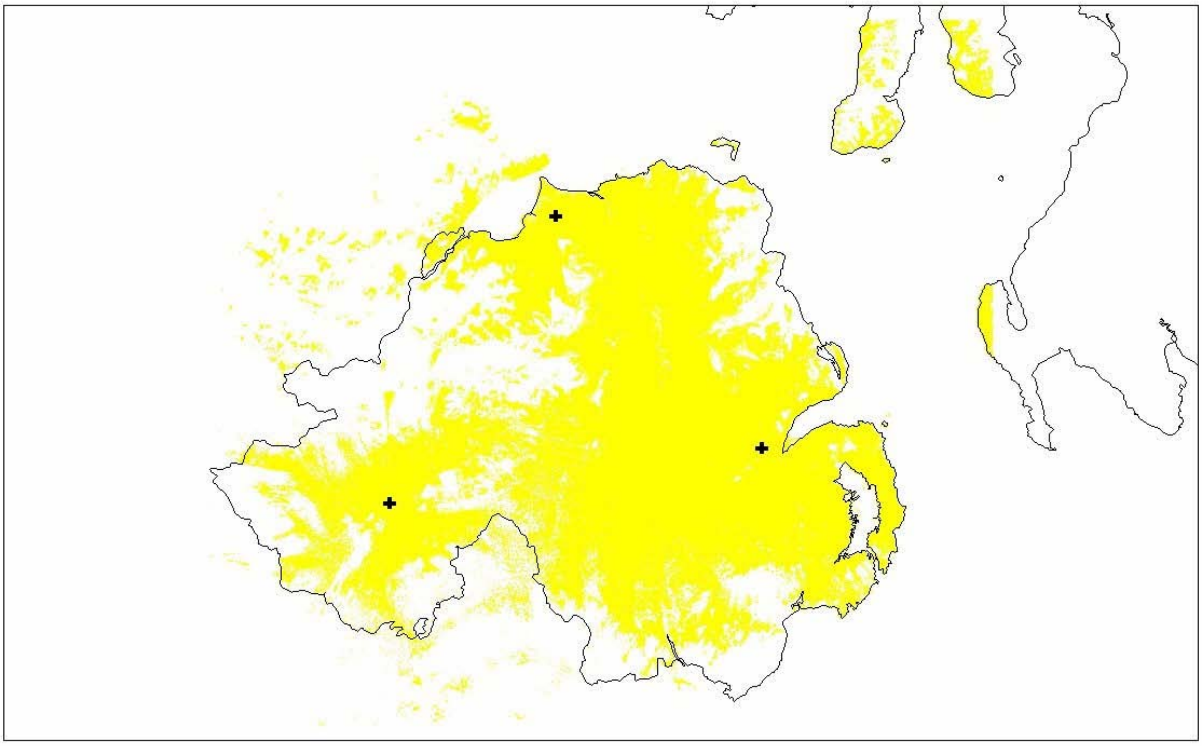
A5.7 We are discussing with the operators of the existing DTT multiplexes the feasibility consequences of making any technical adjustments to the DSO plan.

Northern Ireland

A5.8 A relatively small number of TV transmission sites (3 main transmission sites and 43 relay transmission sites) are used in Northern Ireland. Spectrum use is therefore not too intense. However, there is a large interaction with the Republic of Ireland with overspill coverage from both sides along the land border. There is also some interaction with Scotland. NGW's study shows that 60 per cent of Northern Ireland households could be covered using an aggregated network of four geographic interleaved lots.

A5.9 Arqiva subsequently carried out similar work on DSO spectrum efficiency for Northern Ireland, suggesting improved national coverage of around 85 per cent (see figure A5.2). Again, this would require changes to the DSO frequency plan, and any such changes would need to be agreed by us in consultation with DSO stakeholders and also agreed by our European neighbours where appropriate.

Figure A5.2. Potential coverage from NI main transmission sites from optimisation of interleaved spectrum



Source: Arqiva/Ofcom

Wales

A5.10 Due to its geography and population distribution, it takes almost the same number of transmission sites (and thus frequencies) to cover Wales as it does to cover Scotland, which has four times the land area and twice the population. There is also a widespread interaction with Ireland all along the west coast of Wales, and an interaction with England in the north, east and south of Wales. Thus the spectrum will be very intensively used after DSO in Wales, with relatively little interleaved spectrum remaining.

A5.11 There is little prospect of a significant improvement in available interleaved spectrum capacity being possible in Wales without extensive and complicated changes to the DSO plan. In addition, DSO preparations for Wales are already far advanced (switchover starts in 2009), with DSO transmitter equipment already installed or ordered. Any late amendments to these plans to improve DSO spectrum efficiency are likely to mean additional costs, such as having to replace already installed equipment.

England

A5.12 A similar situation in respect of interleaved spectrum availability exists for England as described for Wales above. There are too many internal and external interactions for significant additional spectrum efficiency to be realised through changes to the DSO plan. Again, DSO preparations for parts of England are far advanced (Border DSO in 2008/9, Westcountry DSO in 2009, Granada DSO in 2009), and Whitehaven has already switched over.

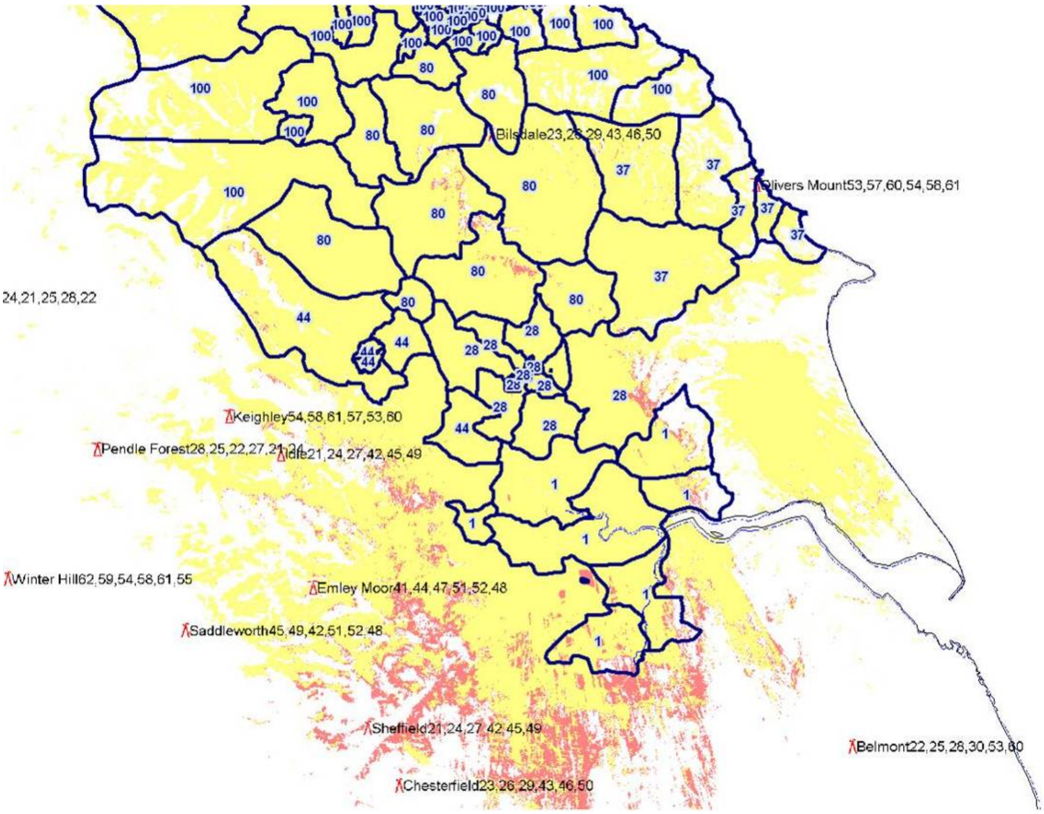
Potential impact of new DTT services on existing DTT services

A5.13 As noted in Section 5, we have considered three options for the protection of existing DTT services – DPSA only, JPP and median. In the following paragraphs we provide a more detailed example of the impact of new DTT services on existing DTT services for each of the three options.

A5.14 To illustrate the practical effect of these three service protection options we have examined in more detail the potential impact of DTT use of a geographic interleaved lot in Sheffield. The new Sheffield DTT service would risk interfering with the existing planned overlapping coverage of Digital 3 and 4's PSB2 multiplex from the Bilsdale transmission site. This example is a worst case example of the maximum potential interference to DTT coverage from the Sheffield lot, using the different protection options, of the 71 main transmission sites we have analysed so far.

A5.15 The results are illustrated below. It can be seen that most of the loss of existing planned Bilsdale PSB2 coverage under the least protective of the three options (DPSA) would be in the Yorkshire region. However in practice few households in Yorkshire would be expected to watch PSB TV transmitted from Bilsdale in this area of Yorkshire, as the Bilsdale transmission site is carrying Tyne Tees regional programmes. Establishment survey data from BARB confirms this. Figure A5.3 shows the postcodes in blue where 1 per cent or more of the households watch Tyne Tees. It can be seen that most of the potential losses in transmissions from Bilsdale (red areas) are well to the south of the transmission site and outside these 'at least 1 per cent Tyne Tees' postcodes.

Figure A5.3 Bilsdale losses and BARB postcodes (per cent households watching Tyne Tees)



Source: NGW/Ofcom

A5.16 So, as shown in table A5.3, for the DPSA-only option, the potential impact of the new Sheffield DTT service on the households which can receive DTT signals transmitted from Bilsdale PSB2 reduces from a theoretical number of around 250,000 households potentially losing the option of watching Tyne Tees (as well as Yorkshire ITV) to around 8,000 if only the losses in the BARB overlap postcodes are taken into account. Furthermore BARB provides an indication of the proportion of households in each overlap postcode actually watching Tyne Tees or Yorkshire e.g. in YO8 (Selby, 20km south of York) postcode, 1 per cent of households watch Tyne Tees; whilst in YO62 (Helmsley, 20km north of York) postcode, it is 80 per cent. If these proportional data are also applied, they further reduce the predicted loss to viewers in Yorkshire of the choice of Tyne Tees PSB signals from Bilsdale to an estimated 335 households.

Table A5.3 Impact of a new Sheffield DTT service on overlaps

DSO Victim	DDR Interferer	Predicted Maximum Gross Loss to Victim (Households)		
		DPSA Only	Median	JPP
Bilsdale PSB2	New Sheffield DTT			
	With Template	250,568	192,384	69,311
	BARB Postcodes	8,073	6,851	352
	BARB Proportional	335	83	4

Source: Ofcom

A5.17 Similar types of effects would be observed for other new interfering transmissions arising from DTT use of geographic interleaved spectrum, although on the basis of our more extensive analysis to date the Bilsdale example above is the largest.

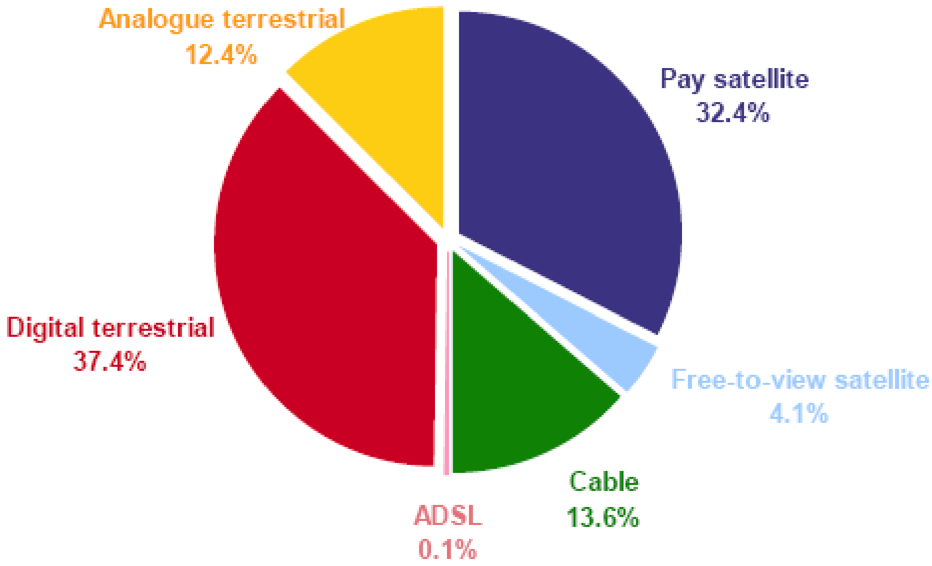
Potential mitigating factors

A5.18 The previous subsection shows the potential mitigating effect of applying the BARB survey data to the predictions of overlap coverage loss for existing DTT services. Other potential mitigating factors are set out in the following paragraphs.

A5.19 DTT services are protected from interference for 99 per cent of the time. Thus if interference occurs for more than 1 per cent of the time in a pixel, the signal is judged to be too poor for that pixel to be counted as covered by the transmissions concerned. However, some households may have higher tolerance thresholds in terms of interference. For example some may not notice, or may be willing to tolerate, interference if it occurs for, say, 2 per cent of the time or some other higher, but still low, percentage. Some of the overlap coverage lost due to new DDT services using geographic interleaved spectrum may only just be exceeding the 1 per cent time interference threshold. In other words all the existing DTT services could still be received after a new service started without any changes to receiving equipment, but the level of interference to one of the signals could be slightly higher than 1 per cent.

A5.20 The latest Ofcom research on the communications market (see http://www.ofcom.org.uk/research/tv/reports/dtv/) includes a breakdown of the means of reception on primary television sets in UK household, as per Figure A6.4. Even assuming all the current analogue terrestrial households switch to DTT after DSO, only about 50 per cent of UK households will be using DTT for their main sets. This is another mitigating factor that could be taken into account when considering the predicted DTT overlap losses. There will be more households using DTT for their secondary sets (up to 76 per cent of all TV sets according to Ofcom research); but as secondary sets are, by definition, generally less used, the likelihood of households noticing interference, even if it occurs for more than 1 per cent of the time, is also less.

Figure A5.4 Platform Share of Main Television Sets, Q4 2007



Source: Platform operators, GfK research, Ofcom estimates.

A5.21 It is important to note that actual affected households should not lose coverage, just the choice of where it comes from, as other transmission sites should still provide an alternative, though realigned and/or replacement aerials could be needed.

Annex 6

Phasing of the award of lots at candidate transmission sites

A6.1 In section 6 we set out here a list of candidate sites and channels for award, based on the set of 71 transmission sites listed in the NGW technical report annexed to our December 2007 Statement, plus 8 transmission sites arising from expressions of interest following the January stakeholder event plus transmission sites for the Crown Dependencies.

A6.2 We also proposed to a series of awards:

- Initial phased award of medium lots in the areas where DSO is before spring 2010 and where there are existing RTSLs (these three sites are Caldbeck, Winter Hill and Wenvoe).

- A combined award of lots most suitable for aggregation in all areas in a simultaneous process.

- Phased awards of medium lots in those areas not already awarded in the initial phase, where these are supported by a suitably developed expression of interest.

A6.3 The table below sets out which sites would be awarded in each phase. We have identified two channels for most of the 25 indicative transmission sites suitable for local television and DTT given in Table 13 of the DDR statement. This has allowed us to include the relevant sites in both the combined awards and the phased awards.

Table A6.1 Phased awards of geographic interleaved spectrum

<table>
<tr><th>Site</th><th>Indicative lot type</th><th>DSO expected by end of</th><th>Comments</th></tr>
<tr><td colspan="3">Initial phased awards – proposed for late 2008 or early 2009</td><td rowspan="5">Lots in these awards may be attractive in particular to existing or potential local TV operators interested in broadcasting to a wider footprint or population, e.g. metropolitan areas. Such operators may also be interested in broadcasting to a number of locations or areas and so aggregating a number of geographic lots. In general such services would be provided either on a commercial basis or partially publicly funded in some manner.

These sites are used by existing RTSLs and we are committed to including them in this award.</td></tr>
<tr><td>Caldbeck</td><td>Medium</td><td>2009</td></tr>
<tr><td>Winter Hill</td><td>Medium</td><td>2010</td></tr>
<tr><td>Wenvoe</td><td>Medium</td><td>2010</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="3">Combined award – proposed for 2009, shortly after the cleared award</td><td rowspan="6">Lots in this award may be attractive in particular to broadcasters interested in serving a substantial proportion of the UK. They might wish to aggregate numerous geographic lots in order to form a sub-UK</td></tr>
<tr><td>Caldbeck</td><td>Medium</td><td>2009</td></tr>
<tr><td>Winter Hill</td><td>Large</td><td>2010</td></tr>
<tr><td>Wenvoe</td><td>Large</td><td>2010</td></tr>
<tr><td>Mendip</td><td>Large</td><td>2010</td></tr>
<tr><td>Craigkelly</td><td>Large</td><td>2011</td></tr>
</table>

Site	Indicative lot type	DSO expected by end of	Comments
Black Hill	Large	2011	multiplex. Award of the sites is confirmed unless responses to this consultation demonstrate convincingly that a site should not be included in the award. Sites may be added to this award if we receive sufficiently persuasive expressions of interest.
Oxford	Large	2011	
Waltham	Large	2011	
Belmont	Large	2011	
The Wrekin	Large	2011	
Ridge Hill	Large	2011	
Emley Moor	Large	2011	
Sutton Coldfield	Large	2011	
Sandy Heath	Large	2011	
Sudbury	Large	2011	
Tacolneston	Large	2011	
Hannington	Large	2012	
Rowridge	Large	2012	
Crystal Palace	Large	2012	
Heathfield	Large	2012	
Dover	Large	2012	
Bilsdale	Large	2012	
Pontop Pike	Large	2012	
Londonderry	Medium	2012	
Divis	Large	2012	
Phased awards – proposed for early 2010 and early 2011, in advance of DSO			
Selkirk	Medium	2009	Lots in these awards may be attractive in particular to existing or potential local TV operators interested in broadcasting to a wider footprint or population, e.g. metropolitan areas. Such operators may also be interested in broadcasting to a number of locations or areas and so aggregating a number of geographic lots. In general such services would be provided either on a commercial basis or partially publicly funded in some manner. These sites will be included in these awards only if a persuasive case is made within the following time limits: for the award proposed for early 2010 – by September 2009; for the award proposed for early 2011 – by September 2010. Sites may be added to the stage three award if a persuasive case is made by the time limits shown above.
Beacon Hill	Medium	2009	
Stockland Hill	Medium	2009	
Huntshaw Cross	Medium	2009	
Plympton	Medium	2009	
Redruth	Medium	2009	
Caradon Hill	Medium	2009	
Mendip	Medium	2010	
Preseley	Medium	2010	
Carmel	Medium	2010	
Llanddona	Medium	2010	
Lancaster	Medium	2010	
Saddleworth	Medium	2010	
Storeton	Medium	2010	
Pendle Forest	Medium	2010	
Moel y Parc	Medium	2010	
Kilvey Hill	Medium	2010	
Bristol Ilchester Crescent	Medium	2010	
Bristol Kings Weston	Medium	2010	
Balgownie	Medium	2010	
Rosemarkie	Medium	2010	
Rosneath VP	Medium	2010	
Bressay	Medium	2010	
Keelylang Hill	Medium	2010	
Rumster Forest	Medium	2010	
Eitshal	Medium	2010	

Site	Indicative lot type	DSO expected by end of	Comments
Tay Bridge	Medium	2010	
Perth	Medium	2010	
Knockmore	Medium	2010	
Angus	Medium	2010	
Durris	Medium	2010	
Douglas	Medium	2010	
Craigkelly	Medium	2011	
Black Hill	Medium	2011	
Darvel	Medium	2011	
Luton	Medium	2011	
Oxford	Medium	2011	
Waltham	Medium	2011	
Belmont	Medium	2011	
The Wrekin	Medium	2011	
Ridge Hill	Medium	2011	
Emley Moor	Medium	2011	
Sutton Coldfield	Medium	2011	
Olivers Mount	Medium	2011	
Sheffield	Medium	2011	
Nottingham	Medium	2011	
Kidderminster	Medium	2011	
Lark Stoke	Medium	2011	
Brierley Hill	Medium	2011	
Keighley	Medium	2011	
Malvern	Medium	2011	
Bromsgrove	Medium	2011	
Fenton	Medium	2011	
Sandy Heath	Medium	2011	
Sudbury	Medium	2011	
Tacolneston	Medium	2011	
Poole	Medium	2012	
Guildford	Medium	2012	
Hemel Hempstead	Medium	2012	
Hannington	Medium	2012	
Rowridge	Medium	2012	
Crystal Palace	Medium	2012	
Heathfield	Medium	2012	
Dover	Medium	2012	
Midhurst	Medium	2012	
Salisbury	Medium	2012	
Reigate	Medium	2012	
Whitehawk Hill	Medium	2012	
Tunbridge Wells	Medium	2012	
Bluebell Hill	Medium	2012	
Bilsdale	Medium	2012	
Pontop Pike	Medium	2012	
Londonderry	Medium	2012	
Divis	Medium	2012	
Limavady	Medium	2012	
Brougher Mountain	Medium	2012	

Site	Indicative lot type	DSO expected by end of	Comments
Fenham	Medium	2012	
Jersey and Guernsey	Medium	2013	

Annex 7

Considerations in the choice of auction design

A7.1 In this annex we examine the auction designs that we could use for the series of awards that we proposed in section 6 of this document. The topics we cover are:

- factors that can affect the efficient outcome of an auction; an efficient outcome being one where the winners are those most likely to make optimal use of the spectrum; and
- candidate auction designs for the proposed awards.

Factors that may affect the efficiency of an auction

A7.2 One of our key duties is to secure the optimal use of the radio spectrum. In awarding spectrum licences we consider that auctions offer the best way of ensuring an outcome that will deliver the optimal value for society. Auctions are the most open, transparent and non-discriminatory way of determining who should hold licences. In auctions the bidding process determines which bidders are prepared to pay most for the spectrum. These bidders are likely to be those that place the highest value on the spectrum and will try to make optimal use of it. A well designed auction process should have an efficient outcome, i.e. it should give the maximum flexibility for the market to determine the best use of the spectrum and the identity of the users.

A7.3 In considering what the best auction design would be for the award of the geographic interleaved spectrum we first looked at what could affect the auction's efficiency. The most important factors are:

- *Aggregation risks* – Some bidders may want to offer services in more than one area. The success of their business case could depend on winning spectrum lots in all of the areas of interest to them. If bidders have to bid separately for lots they will face uncertainty about how much to bid, and risk winning unwanted or low value subsets of their full demand. This is what is meant by the 'aggregation risk'. In auction design the best way to meet this risk is to auction the affected lots simultaneously and allow bids for combinations of lots, i.e. package bidding.

  For this award different types of bidder will have different views on the aggregation risk. For local TV bidders there may be no such risk because the business case for running a local TV service in one area could be largely independent of the business case for another area. On the other hand, some bidders may want to aggregate a number of lots to provide a service covering a much wider set of consumers and they could face substantial aggregation risks. If the auction design does not address these risks it may deter them from entering the auction or lead to inefficient bidding behaviour and spectrum allocation outcomes. It will be important for an efficient auction outcome to ensure that potential bidders are not deterred in this way.

- *Substitution risks* – An auction may be for a series of spectrum lots that are very similar, so that bidders may be prepared to obtain any sub-set of them, i.e. the lots are substitutes for each other. Their preference for one lot rather than another is likely to depend on the relative prices of the lots concerned. If bidders are not allowed to express their preferences they may be forced to buy one lot when, at the prevailing prices, they would have preferred another. This is what is meant by 'substitution risk'. In auction design one way to meet this risk is by selling substitute lots in the same auction and allowing bidders to switch between lots as prices change.

For the award of lots of geographic interleaved spectrum, substitution risks seem to be limited because a licence for one area is unlikely to be a substitute for another area. But it is not entirely absent. Some bidders may be prepared to develop services in one of a number of (potentially overlapping) areas and make their choice on the basis of the relative prices of the spectrum. Also, at some locations we are offering more than one frequency and some bidders may be prepared to obtain any one of them at a particular location, balancing price and potential coverage.

- *Threshold risks* – Package bidding removes aggregation risks but it may then introduce another risk for bidders seeking individual lots or small packages of lots. These bidders may find it difficult to compete against a bidder that is seeking a larger package made up of the lots that they want. The smaller bidders would defeat the larger bidder if the sum of their valuations was higher than his and all bid to their true valuations. The problem is that some of the smaller bidders may keep their bids below their valuation in the hope that others may make sufficiently high bids for the large bidder to be defeated. If enough smaller bidders attempt to free ride in this way it may be that the large bidder will win. This would be undesirable if the more efficient outcome was for the smaller bidders to win. This is what is meant by 'threshold risk'.

  A related issue is the possibility that aggregators may not bid for all the packages for which they have value. This could have the affect that smaller bidders are unable to win specific individual lots, even though they place a higher value on a lot than the incremental value of their rival. In effect, aggregators are overstating their incremental value of a larger package relative to a smaller one by not bidding at all on the smaller one even if it has value to them. This should not happen if aggregators are pursuing a value-based bid strategy and behave rationally as the aggregator would benefit from making a bid for the smaller package. However, if an aggregator deviated from value-based bidding or simply failed to bid on all possible packages that it would be prepared to win, then small bidders might be adversely affected.

  In principle, such risks may be a concern for the simultaneous award of large lots that we propose, given that there are some spectrum lots for relatively small geographic areas. But the fact that there may be substitute lots available in the other auctions should help to mitigate this. It is important that the combination of auction formats selected across all the proposed awards allow a reasonably level playing field between bidders wishing to aggregate lots and those wanting single lots only.

- *Common value uncertainty* and *price discovery* – Where bidders have similar but uncertain business cases it may be useful for them to have information on their competitors' bids. This could allow them to refine their own valuations of the spectrum. Moreover, even if bidders' business cases are very different they may still benefit from price discovery, as information about the underlying value of lots and level of demand for lots may help to assess aggregation risks and opportunities for selling the spectrum after the auction.

It is difficult to judge how significant common value uncertainty and price discovery might be for different potential bidders in these awards. The test is whether a bidder is likely to revise its own business case and hence bid strategy if it has information about others' valuations. For this spectrum all lots have significant differences and there could be a diversity of business cases.

- *Bidder asymmetries* – In some auctions there may be large differences in the strength of bidders interested in the same spectrum. Some may be well established in a market or have large financial resources. Others may be relatively new to a market or be small companies with few resources. Such asymmetries can have a big impact on participation in an auction and on bidder behaviour. This can undermine the auction's efficiency.

  There are two main problems. First, small or weaker bidders are more vulnerable to overpaying for licences and so may be more cautious in their bidding than large or strong rivals. Second, small bidders may be discouraged from participating if they think they have little chance of outbidding strong rivals. Using sealed bids in a single round process, or restricting the transparency of a multi-round process, may help to reduce the impact of bidder asymmetries, as these approaches make it difficult for large players to assess what bids may be required to defeat smaller rivals.

  Bidder asymmetries could be a concern for this spectrum, for example where local players are competing against strong bidders, such as incumbent media or telecoms providers with established national or regional operations.

- *Complexity for bidders* – It is important that an auction is not unduly complicated for bidders. If bidders do not fully understand the process they may not develop a sound bidding strategy. In that case bidders with the best business case may lose out and the auction outcome will be inefficient. Whatever auction format is chosen it is important to ensure that all potential bidders are given the opportunity to understand the process and key rules fully.

Auction formats we have considered for the proposed awards

A7.4 In this subsection we provide a more detailed description and relative merits of five potential auction formats that we could use for the proposed awards, in the context of their relative ability to address the issues discussed above.

Single unit sealed bid auctions

A7.5 This is a very simple auction format. Bidders are invited to submit a sealed bid for an individual lot during a single round of bidding. A number of lots may be sold at the same time but the sale of each is effectively a separate auction. Bidders decide how much to bid for a lot, and their bid is valid so long their bid is equal to or greater than the reserve price the auctioneer sets. The winning bid for a lot is the highest bid for that lot, with any ties resolved using a random process.

A7.6 Two alternative pricing rules are then possible to determine how much the winning bidder actual pays, either:

- *First price* – the winning bidder pays the amount of their own bid;

- *Second price* - the winning bidder pays the amount of the highest losing bid.

A7.7 Generally, we prefer the second price approach for our spectrum auctions. The first price rule implies strategic complexity for bidders. They must set their bid below their value in order to gain a surplus from winning. The difficulty is in deciding how much to shade down their bids while minimising the risk that their bid will be too low to win. This complexity does not arise with the second price rule. Bidders can simply bid their own value, as they know that if they win they will pay no more than the bid of their strongest rival and will accordingly never risk overpaying for the spectrum. However, in cases where there are substantial bidder asymmetries, the use of a first price may sometimes be preferable if it encourages participation. The uncertainty that the first price rule introduces holds risks for all bidders and this can lead weaker bidders to perceive that they have a reasonable chance of winning relative to larger bidders.

A7.8 There is also the question of how much auction information to reveal to bidders. There are two possible approaches:

- *No transparency* – Bidders submit their applications and bids for lots at the same time. No information about the nature of other participants is provided to bidders until the end of the process*.*

- *Bidders are pre-announced* – Bidders submit applications in advance of the auction and the identity of all qualified bidders for each lot is announced before the auction starts. If there is more than one bidder for a given lot, the auction proceeds; if there is only one pre-qualified bidder the lot is awarded to that bidder at the reserve price.

A7.9 The simple sealed bid auction format is only appropriate in the case that none of the lots is a close substitute or complement for another and there are no significant synergies between any of the lots. Even in these cases, it may not be appropriate if there are perceived benefits from using an alternative multi-round process to elicit price discovery and ease common value uncertainty.

Single unit ascending bid auctions

A7.10 This is a multi-round alternative to the sealed bid auction of a single spectrum lot. In the first round, bidders are invited to submit bids at a reserve price. If there is more than one bid the auction continues and in subsequent rounds prices are increased. In every round, the bidders can therefore evaluate the increasing price for the spectrum lot and determine whether to stay in the auction or drop out. Bidding continues over a number of rounds until there is only one bidder left. In the event that all remaining bidders stop bidding at the same time, a random process is used to resolve the tie.

A7.11 In this format, the standard approach is for bidders pay the bid amount applicable in the last auction round when there was more than one bid. This is roughly similar to a second price rule in a sealed bid, as the final price is set by the marginal bidder.

A7.12 The same transparency options as described for the sealed bid are available in the period before the auction starts. In addition, there also is a choice as to whether to reveal the number and identity of bidders submitting bids after each round of the auction. Revealing this information may further reduce any common value uncertainty.

A7.13 This format is also only appropriate in the case that none of the lots available are close substitutes or complements for the other. The advantage of this approach over the sealed bid auction is the scope for price discovery and easing common value uncertainty.

Simultaneous multiple-round auctions

A7.14 Like the single unit ascending bid auction, a simultaneous multi-round auction (SMRA) takes place over a number of rounds. However, it entails a number of lots being bid for in each round. Bidders place bids on one or more of the available lots. Prices increase from round to round and in response bidders are able to switch demand between lots, subject to any rules on switching that are established for the auction. The auction closes for all lots at the same time when no new bids are made for any of the lots. Each lot is then assigned to the highest bidder for the lot.

A7.15 SMRAs have been widely used for assigning spectrum licences. The standard SMRA format features a number of distinct spectrum lots. The price of individual lots only rises when they receive a new bid. Thus, over the course of the auction, the relative prices of different lots will vary and bidders can switch between them on the basis of these changing relative prices. The highest bid for some lots may be made before the final round.

A7.16 The SMRA should produce reasonably efficient outcomes where there are a number of substitutable lots and common value uncertainty. Bidders benefit from being able to observe the behaviour of their competitors and alter their demand in response to changes in the relative prices of lots. This mitigates both winners' curse (of under-informed bidders accidentally bidding too much) and substitution risks, and reduces aggregation risks, relative to a sealed bid auction.

A7.17 A simple pay-what-you-bid pricing rule has typically been used in SMRAs. The incentives this rule creates are roughly analogous to the second price rule in a sealed bid or the approach described above for the single unit ascending bid auction. [explain why a different rule gives similar incentives] In all cases, prices are determined by the highest bid of the marginal bidder for each lot.

A7.18 Our preferred approach to transparency would be to reveal the number and identity of applicants before the auction. This makes it easier to ensure that associated bidders do not participate in the auction. During the auction, the revelation of each bidder's activity increases information for other bidders (over and above the knowledge of increasing lot prices that bidders already have) and may therefore further reduce common value uncertainty. But where there are bidder asymmetries, restricting the release of this information may encourage participation by smaller players who are potentially less able to make efficient use of such information.

A7.19 A potential drawback with the simple SMRA format is that it does not fully deal with aggregation risk. Over multiple rounds, bidders can monitor demand and prices, so as to develop an informed judgement of their likelihood of winning complementary lots. However, they still face difficult decisions about the values they place on complementary lots. There is also the risk of being stranded with an unwanted subset of lots if the price of some lots in the full wanted set rises too high for their budget. There are various amendments to the activity rules governing how bidders can bid in each round that can be used try to reduce this aggregation risk. For example bidders may be allowed to withdraw bids to avoid the risk of being stranded with what transpire to be unwanted sub-sets of lots. But such rules make the auction process more complex, without actually completely eliminating the aggregation risk.

A7.20 Selling licences in a simultaneous process also introduces scope for strategic behaviour by bidders. For example, as bidders can switch demand across different lots, it is possible to hide true demand for one lot by bidding on an alternative lot and then switching later in the auction. The scope for such behaviour may be increased by rules, such as relaxed activity requirements, that are designed to ease aggregation risks. Depending on the nature of strategic bidding, this may compromise the efficiency of the auction outcome.

Sealed bid auctions with package bidding

A7.21 Package bidding in combinatorial auctions is used for assigning multiple lots where bidders have synergies between them. Bidders can submit separate bids for each specified combination of lots they would like to acquire. They can submit bids for individual lots or for packages of lots, and place different amounts on each lot and package. The winning bidders are determined by calculating the combination of bids that generates the highest revenue.

A7.22 Package bidding can be implemented in either a single-round sealed bid or a multiple round auction. In the single round sealed bid format, bidders have a single bid window in which to submit package bids for every combination of lots (packages) that they are willing to buy.

A7.23 As with the simple sealed bid, there are two possible pricing rules:

- first price rule – winning bidders pay the amount of their winning bids; or
- second price rule – winning bidders pay prices set at the minimum level where losing bidders (or groups of losing bidders) would not wish to purchase spectrum instead of the winners.

A7.24 We generally prefer to use a second price rule, to make it simpler for bidders when deciding what to bid. The second price rule is more complex for the auctioneer to implement in combinatorial auctions than in single unit auctions, although bidders are not exposed to the complexity concerned. It is based on the principle that a winning bidder should pay the least amount consistent with them winning the spectrum while there is no bidder or group of bidders prepared to pay more. An algorithm must be used to calculate the final price which achieves this requirement. This approach mimics the outcome of an open competitive process and provides good incentives for bidders to bid at or close to their true value.

A7.25 The transparency choices are essentially the same as for the single unit sealed bid.

A7.26 The main benefit of package bidding is that it allows bidders to eliminate aggregation risks, as they can bid up to their full value for any selected package of lots, without risk of being stranded with unwanted subsets of their total demand. Typically, this may create a more level playing field between bidders trying to aggregate lots and those not trying to aggregate (or aggregate to a lesser extent), thus facilitating more efficient auction outcomes.

A7.27 Under certain circumstances package bidding in a single round environment may create threshold risks for small bidders.

A7.28 Threshold risks are primarily a problem when a first price rule is used. If a second price approach is used, strategies of bidding below true value are unlikely to change the distribution of payments across the winning bidders while always leading to risks of not winning.

A7.29 A further issue with package bidding is its potential complexity for bidders, as all the various permutations of packages have to be examined and bid for. If there are many lots, there will be very large numbers of package options for bidders to consider. However, single round package bidding would imply that bidders should have plenty of time in advance to consider their bids. The requirement for an algorithm to determine the winners and solve prices also means that the outcome is not as easy to check as with more basic formats. But this is mainly a problem for the auctioneer and should not affect bidding behaviour.

A7.30 Finally, as with the single unit sealed bid, the sealed bid package bid auction does not provide any scope for price discovery and reducing common value uncertainty.

Combinatorial clock auction

A7.31 In a simple clock auction bidding for a number of similar lots takes place in a series of rounds. The auctioneer announces the price per lot at the beginning of each round and bidders say how many lots they would like to buy at that price. Bidding continues until the aggregate number of lots bidders are willing to buy at the current price is no more than the number available. Each bidder remaining in the auction at the end wins the number of lots it bid for in the final round and pays the price set for the final round.

A7.32 The combinatorial clock auction (CCA) is a development of this format. It allows package bidding over a number of rounds. This both eliminates aggregation risks and alleviates common value uncertainty. The CCA consists of two phases of bidding: the primary bid rounds; and a supplementary bids round:

- *Primary bid rounds* – The primary bid rounds follow a clock auction format. Bidders make a single bid in each round for a package of one or more lots. Where there is excess demand for at least one of the lots, prices for the affected lots are increased in the next primary bid round, and the rounds continue until there is no excess demand for any lots.

- *Supplementary bids round* – The supplementary bids round is in the form of a single round sealed bid auction with package bidding. Bidders have the opportunity to make multiple bids for alternative packages of lots, subject to constraints created by their primary round bids.

A7.33 We propose to use this format in the award of the DDR cleared spectrum, for the reasons set out in our parallel consultation on the cleared award auction. We have already used this format for the UK 10 GHz to 40GHz auction in February 2008 and the L Band award in May 2008. We have also decided to use it in the 2.6 GHz award.

A7.34 Following the conclusion of the supplementary bids round, the auctioneer identifies the highest value combination of bids that can be accommodated, drawing on all valid bids from the primary and supplementary bids rounds and taking at most one bid from each bidder. This process is the same for the sealed bid package auction format described above (except for the inclusion of bids from earlier rounds and associated constraints on supplementary bids).

A7.35 To date in all proposed implementations of the CCA format, we have proposed using a ‘second price’ rule to determine the price for each winning bid for a package of lots. It is unlikely that we would take a different approach if we used a CCA for the award of geographic interleaved spectrum, given the strong benefits of a second price approach, as described above for the sealed bid package bid format.

A7.36 With respect to transparency before the auction, our preferred approach has been the same as for a standard SMRA, i.e. to reveal the number and identity of applicants. This makes it easier to ensure that associated bidders do not participate in the auction. As with the standard SMRA however, the case for transparency during the CCA is less certain. Transparency about which bidder is bidding for which lot increases information for other bidders and may therefore further reduce common value uncertainty. However, in an open process it may also facilitate tacitly collusive outcomes and allow leverage strategies to be deployed more effectively, i.e. the limitation of package bids to reduce the chances of other bidders winning. In many cases, most of the common value uncertainty can be addressed by simply by revealing aggregate information (e.g. total number of bids for each lot) round-by-round. This significantly limits the ability of individual bidders to engage in strategic behaviour such as leverage or tacit collusion.

A7.37 The advantages of this format with respect to aggregation and substitution risks are similar to those discussed for the single round sealed bid package bid auction. The main advantage of this approach relative to the sealed bid version is the scope for price discovery and hence alleviating common value uncertainty. Against this, one must consider the possibility that threshold risks are aggravated in the context of an open auction, because bidders can potentially send signals to each other through their bids, and have more information on which to judge whether strategic behaviour may be effective. Such concerns may, however, be substantially mitigated through restrictions on transparency.

Annex 8

Description of combinatorial clock auction design

Introduction

A8.1 The combinatorial clock auction (CCA) allows bidding for packages of lots over a number of rounds. It consists of two bidding stages: the primary bid rounds; and a supplementary bids round:

- *Primary bid rounds* – The primary bid rounds follow a clock auction format. The auctioneer announces the price per lot at the beginning of each round and bidders say how many lots they would like to buy at that price. Bidders make a single bid in each round for a package of one or more lots. Where there is excess demand for at least one of the lots, prices for the affected lots are increased in the next primary bid round, and the rounds continue until there is no excess demand for any lots.

- *Supplementary bids round* – The supplementary bids round is in the form of a single round sealed bid auction with package bidding. Bidders have the opportunity to make multiple bids for alternative packages of lots, subject to constraints created by their primary round bids.

A8.2 Following the conclusion of the supplementary bids round, the auctioneer identifies the highest value combination of bids that can be accommodated, drawing on all valid bids from the primary and supplementary bids rounds and taking at most one bid from each bidder. The bids making up the highest value combination are the winning bids.

Activity rules and bid submission in the primary bid rounds

A8.3 In each round of the primary bid rounds, bidders may submit a single bid for a package of lots, based on the current clock prices.

A8.4 The minimum participation requirement in the auction is that a bidder must submit a valid primary bid in the first primary bid round. If a bidder fails to meet this requirement it will be excluded from the award process and forfeit its deposit.

A8.5 There is an activity rule which applies throughout the primary bid rounds. In each round, the sum of eligibility points associated with the component lots in a bidder's bid cannot exceed their current eligibility limit. In the first round, a bidder's initial eligibility limit is determined by the level of its deposit. In subsequent rounds, eligibility is determined by the level of a bidder's activity in the previous round. This activity is measured by the total number of eligibility points associated with the component lots in its bid. For example, if a primary bid has 15 eligibility points attributable to it the bidder's eligibility limit for the next primary bid round is 15; and that bidder cannot make a primary bid in any subsequent primary bid round for a selection of lots that has more than 15 eligibility points attributable to it.[50]

[50] In effect this is a 100 per cent activity requirement and differs from the activity rule normally used in SMRAs, where the auctioneer may set an activity requirement between 0 per cent and 100 per cent

A8.6 If a bidder does not submit a valid primary bid in a primary bid round its eligibility limit in subsequent primary bid rounds will be zero.

A8.7 The activity rule ensures that aggregate demand in the auction – as measured by the sum of eligibility points associated with all bids made in a single round – cannot increase.

Clock prices and bid increments

A8.8 There is a separate price clock for each lot. The clock prices in the first round are set equal to the reserve prices.51

A8.9 In subsequent rounds, clock prices of lots in excess demand are increased, being set equal to the price for that lot in the previous round plus a bid increment. Prices of lots for which there is no excess demand are unchanged from the previous round.

A8.10 Different bid increments may be used for different lots, and the size of the bid increment may vary from round to round, at the discretion of the auctioneer. In setting the appropriate bid increment, the auctioneer will take into account factors such as the level of excess demand for a lot category; relative prices across lots, the ability of bidders to express preferences for different numbers of lots at different price points and the pace of the auction.

Managing the pace of the auction

A8.11 Rules concerning bid increments and the timing of rounds will affect the pace and management of the auction process. The auctioneer needs flexibility in managing the pace of the auction such that it can proceed as quickly as possible, without jeopardising efficiency.

A8.12 Rounds need only be as long as is necessary to allow bidders to input, check and submit their bids. As with bid increments, the auctioneer needs flexibility to determine the length of a round. Early in the auction, when bidders are getting used to the system, round lengths of, say, 30 minutes or more may be required. However, later in the auction, when there may be very few new bids or price changes involved in each round, shorter rounds of about 15 minutes or less may be feasible.

A8.13 Intervals between rounds are important in managing the pace of the auction. The auctioneer will have the flexibility to set the timetable for rounds on a day-by-day basis. The interval between rounds will need to be long enough for bidders to digest the result of the latest round and to decide how to bid in the next round. 30 minutes notice of the start of a round should be sufficient. As the auction progresses it may be possible to decrease the interval between rounds and so increase the number of rounds per day.

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for each stage of the auction. The flexibility for SMRA bidders that the variable activity level allows is not so important for package bidding, particularly with a supplementary bids round.

[51] This is different from our proposal for the single unit ascending bid auctions. For that design the first round price would be the reserve price plus an increment. This is related to the rule under which a bidder may make a discretionary bid where it wants to pay less than the round price the auctioneer has set. The discretionary bid must be higher than the previous round price. In the first round this means it must be higher than the reserve price, and it follows that the round price must also be higher than the reserve price. In the CCA we are not proposing to include such a rule as we consider it would overcomplicate the auction.

End of the primary bid rounds

A8.14 At the end of each primary bid round the auctioneer determines whether there is excess demand for any lot given the most preferred packages stated by bidders. If there is excess demand on any of the lots there will be another primary bid round. If, at the end of a primary bid round, there is no lot in respect of which there is more than one bid there will be no more primary bid rounds.

A8.15 The auctioneer may determine that there shall be no further primary bid rounds even if, at the conclusion of a round, there is one or more lots in respect of which there is more than one bid. It may do this where it is satisfied that it is unlikely that the information that would be available to bidders if there were further primary bid rounds would affect the outcome of the auction.

Supplementary bids round

A8.16 All bidders that submitted a valid primary bid in the first primary bid round will be entitled to participate in the supplementary bids round, provided they have not subsequently been excluded from the award process. Bidders are under no obligation to make use of supplementary bids. However, in the event that there are otherwise unallocated lots at the end of the primary bid rounds, they can improve their chances of winning additional lots through making supplementary bids.

A8.17 The supplementary bids round gives bidders the opportunity to raise their primary round bids and to bid for packages of lots that they did not bid for in primary bid rounds. All valid bids received from bidders in both the primary bid rounds and the supplementary bids round are considered in determining the winning bidders.

A8.18 The supplementary bids round is in the form of a single round sealed bid auction with package bidding. Using sealed bids in a single round process may help to reduce the impact of bidder asymmetries, as these approaches make it difficult for large players to assess what bids may be required to defeat smaller rivals.

A8.19 The supplementary bid round will be completed within one day.

Winner determination

A8.20 Winning bids are determined by taking into account all primary round bids and all supplementary bids. The winning bids are the set of bids of greatest total value, subject to:

- no more lots being awarded than are available;
- at most one bid being accepted from each bidder.

A8.21 In the event that there is more that one set of bids of exactly the same greatest total value, the set of bids that has the highest number of eligibility points associated with it will be the winning set of bids. If there is more than one set of such bids a random process shall be used to determine which set of bids is successful.

A8.22 Including in the winner determination all bids made during the auction not only promotes an efficient outcome but should also encourage realistic bidding, as there is always a possibility that any bid submitted could be a winning bid. Further, because all package bids submitted by the same bidder are mutually exclusive, and are accepted or rejected in their entirety, bidders are not exposed to aggregation risks.

Determination of prices to be paid

A8.23 In the CCAs that we have run to date we have use a second price rule to determine the prices paid by winning bidders. These are prices paid for packages of lots by winning bidders such that:

- there is no dissatisfied bidder or grouping of bidders able to suggest an alternative outcome (in terms of prices paid and lots received by the bidder or group) preferred by all group members and which achieves greater total revenue; and
- these are the lowest such prices, so there are not alternative prices satisfying the first condition which all bidders prefer.

A8.24 This corresponds to a notion of competitive pricing, in that winners have paid sufficient such that losers cannot suggest an alternative that does not make the seller worse off. Winners need to pay the minimum amount sufficient for there to be no other bidder or group of bidders willing to make a counter-offer for some or all lots that the seller would prefer.

A8.25 Typically, there are many possible prices satisfying these conditions. Among all these possible prices those closest to the opportunity cost of each bid would be selected.

A8.26 The advantage of this pricing rule over a simpler ‘pay what you bid’ rule is that it substantially reduces the incentives for the remaining bidders at the end of the primary bid rounds to shade their supplementary bids, submitting bids significantly below their valuations. The amount that winning bidders will ultimately pay is determined primarily by the bids of competitors, so there are good incentives to make bids close to the value that bidders place on packages.

Transparency

A8.27 At the end of each primary bid round the auctioneer will announce the level of excess demand for each lot. There are a number of further options for releasing additional information:

- releasing all primary bids on an anonymous basis (i.e. the packages bid on but not who made them); and
- full transparency of all bids made in the primary bid rounds (including the identity of the bidder).

A8.28 Releasing the details of all primary bids on an anonymous basis would help reduce common value uncertainty. The pros and cons of additionally having full transparency are difficult to judge. Full transparency would provide somewhat richer information for bidders to benchmark their valuations against the behaviour of other bidders, and so further reduce common value uncertainty. However, much of this benefit would already have been obtained by releasing these bids on an anonymous basis. Against this, full transparency might facilitate collusive behaviour.

Electronic bidding

A8.29 A CCA of the above form, to be managed efficiently, will be run electronically allowing remote bidding over the internet.

Annex 9

Description of simultaneous multiple round auction design

A9.1 A simultaneous multiple round auction (SMRA) is an auction for a number of lots in which bidding takes place over a series of rounds. In each round bidders simultaneously make bids for any lots that they want to obtain. The number of lots on which a bidder may bid in a round is limited by the auction activity rules, which are explained below. Bidders may switch between lots: a bidder who has bid on a lot in a previous round but does not currently hold the highest current bid on that lot is not obliged to continue bidding on it.

Bid prices

A9.2 In each round, the auctioneer notifies bidders of an 'asking price' for each lot. The asking price of each lot in the first round is the reserve price[52]. Bidders signify their willingness or otherwise to bid for the lot at the asking price. Bidding on all lots takes place simultaneously. Providing at least one bidder bids at the asking price, the asking price becomes the 'standing high bid' for that lot. If only one bidder bids for a particular lot at the standing high bid it becomes the standing high bidder for that lot. If more than one bidder bids for a particular lot the standing high bidder for that lot will be chosen by a random method. A standing high bidder may not bid in the following round in respect of any lot for which it is the standing high bidder.

A9.3 Following the determination of the standing high bidder, the auctioneer specifies a new asking price for a lot. Unless another bidder subsequently raises the bid to the new asking price for that lot the standing high bidder will, at the end of the auction, be awarded that lot at the standing high bid.

A9.4 There is an alternative bidding and pricing rule that allows bidders in each round to set the price they are prepared to pay for a lot. The price must be above the standing high bid and within a maximum that the auctioneer sets. The bidder making the highest bid becomes the standing high bidder. The auctioneer will set prices from round to round by increasing the standing high bid. In the event that there is a tie for the standing high bid, the auctioneer may use a random method to determine which of the tied bidders will be deemed to be the standing high bidder. The other bidder(s) will always be able to bid more in the next round and will not be arbitrarily excluded from further action in the auction.

A9.5 The auction continues until all the bidders who are not currently holding the highest bid for a lot have withdrawn. Each lot is then awarded to the highest bidder at the final standing high bid.

[52] This is different from our proposal for the single unit ascending bid auctions. For that design the first round price would be the reserve price plus an increment. This is related to the rule under which a bidder may make a discretionary bid where it wants to pay less than the round price the auctioneer has set. The discretionary bid must be higher than the previous round price. In the first round this means it must be higher than the reserve price, and it follows that the round price must also be higher than the reserve price. In the SMRA we are not proposing to include such a rule as we consider it would overcomplicate the auction.

Activity rules and bidder eligibility

A9.6 The eligibility points that a bidder holds determines the maximum number of lots that it may bid for in the auction. Unless there are significant differences between lots, in terms of spectrum characteristics or coverage, each lot is assigned one eligibility point.

A9.7 Applicants are required to state how many lots they wish to bid for and this will determine their eligibility points at the start of the auction. Applicants do not have to declare in advance which lots they wish to bid for, as the activity rules allow switching bids between lots as relative prices change.

A9.8 Activity rules are designed to ensure each bidder participates fully in the auction. Bidders should not be able to refrain from bidding until a late stage in the auction, having watched bidding activity in the early rounds. Such bidder behaviour would enable it to assess others' actions without revealing its own strategy. This is counter to a key function of the SMRA, which is the sharing of information between bidders, and all must engage fully to allow this.

A9.9 A bidder is active in a round if it either

- holds the highest bid on one of the lots, *or*
- makes an acceptable bid on one of the lots, *or*
- exercises a waiver. A bidder who would otherwise be required to bid or withdraw from the auction may also exercise one of a limited number of waivers that allows him to take no action in that round without being deemed to have withdrawn from the auction. (See paragraph A9.23 below for discussion of the desirability of waivers.)

A9.10 In order to ensure full participation each bidder will have to meet the activity levels set by the auctioneer, or else lose eligibility points. The auctioneer may decide to set an activity requirement of 100 per cent throughout the auction. Alternatively, it may decide to use activity requirements that become progressively more onerous as prices come closer to final prices. Setting activity requirements in stages in this way is the approach used in many previous SMRAs.

A9.11 The advantage of using stages is that it allows more fluid switching between lots, as bidders do not necessarily need to bid on all of the lots that they might ultimately need until late in the auction when prices are more informative. With this approach, the auctioneer would set an activity requirement between 0 per cent and 100 per cent for each stage of the auction.

A9.12 To illustrate how the activity rule works in general, suppose that eligibility at the start of a round was E. A bidder would need to have activity of at least X*E[53] – this is the Activity Requirement (AR). If the level of activity (A) is less than the activity requirement (AR), eligibility in the next round is reduced in proportion to the shortfall, i.e. eligibility becomes E*A/AR (again rounding to an integer may be required).

A9.13 Here are some examples to illustrate the procedure:

[53] Rounding is required if X*E is not an integer.

- A bidder has seven eligibility points. The activity level factor is 50 per cent. The activity requirement needed to maintain his eligibility points in the next round is therefore four (i.e. 7 x 50 per cent=3.5, rounded up).

- A bidder has eight eligibility points. The activity level factor is 80 per cent. The activity requirement needed to maintain his eligibility points in the next round is therefore seven (8 x 80 per cent=6.4, rounded up). He bids on six lots in the current round. His eligibility points are reduced to seven (6/0.8 = 7.5) for the succeeding round.

- A bidder has eight eligibility points. The activity level factor is 50 per cent. He is the standing high bidder on one lot and bids on two lots in the current round. His eligibility points are reduced to six (3/0.5 = 6) for the succeeding round.

- A bidder has three eligibility points. The activity level factor is 100 per cent. He bids on two lots in the current round and is standing high bidder on no lots. His eligibility points are reduced to two for the succeeding round.

- A bidder has eight eligibility points. The activity level factor is 50 per cent. He is standing high bidder on no lots. He validly exercises a waiver and bids on no lots in the current round. His eligibility points are maintained at eight for the succeeding round.

Deposit and payment rules

A9.14 Deposits are upfront payments that will be forfeited if a bidder breaks auction rules or a winning bidder defaults on its payment. They help to deter frivolous bidders and to reduce any strategic incentives for default. The initial deposit could be either a flat rate or linked to the number of lots an applicant wishes to bid for. In an SMRA the latter approach is normally used. This ensures that the gains from default (to potential defaulters) are diminished and links deposits to bidder demands.

A9.15 Setting bid deposits is less straightforward. Given the possibility that bids in the auction could rise to many times the minimum bid prices, the initial deposits could during the course of the auction become too small a proportion of bids to act as an adequate deterrent to default. The auctioneer will employ a mechanism to ensure that bidders increase their deposits in a way that reflects their aggregate bid levels at various points during the auction.

A9.16 Winning bidders will be required to pay, by a specified time, 100 per cent of the fee for lot(s) they have won, and licences will only be issued after payment has been received. Further, if a bidder defaults on payment it will forfeit its deposit and will remain liable for the outstanding balance and it will not be granted a licence.

Bid withdrawal

A9.17 Bid withdrawal is a means of reducing aggregation and substitution risks by allowing current high bidders to withdraw their bids. Where there are aggregation risks, such that a bidder risks being stranded on a lot for which it has little value when not combined with another complementary lot, there may be an argument to allow bid withdrawal. In addition bidders may face substitution risk, where they are the highest bidder for a lot for which there is a lower priced substitute.

A9.18 Withdrawals allow bidders some flexibility but carry a potential penalty. The bidder making the withdrawal will be liable to pay a penalty if there is no subsequent bid on the lot at or above the withdrawn bid. This penalty might be equal to the difference between the withdrawn bid and the highest admissible bid received on the lot subsequent to the withdrawal (or the reserve price, if there is no subsequent bid).

Managing the pace of the auction

A9.19 Rules concerning bid increments and the timing of rounds will affect the pace and management of the auction process. The auctioneer needs flexibility in managing the pace of the auction such that it can proceed as quickly as possible, without jeopardising efficiency.

A9.20 Bid increments are set by the auctioneer to control the pace of the auction. Large bid increments can be used to accelerate the pace of the auction, but they should not be so large that they lead to an inefficient assignment at the margins. The auctioneer's flexibility to set increments up to 100 per cent should allow him to effectively steer the pace of the auction and react to the level of activity.

A9.21 Rounds need only be as long as is necessary to allow bidders to input, check and submit their bids. As with bid increments, the auctioneer needs flexibility to determine the length of a round. Early in the auction, when bidders are getting used to the system and may have many new bids to submit each round, round lengths of, say, 30 minutes or more may be required. However, later in the auction, when there may be very few new bids or price changes in each round, shorter rounds of about 15 minutes or less may be feasible.

A9.22 Intervals between rounds are important in managing the pace of the auction. The auctioneer will have the flexibility to set the timetable for rounds on a day-by-day basis. The interval between rounds will need to be long enough for bidders to digest the result of the latest round and to decide how to bid in the next round. 30 minutes notice of the start of a round should be sufficient and as activity in the auction slows it should be possible to decrease the interval between rounds and so increase the number of rounds per day.

Waivers

A9.23 Waivers allow a bidder to refrain from bidding in a round without sacrificing eligibility in the next round. It may want to do this because it is unable for technical reasons to submit a bid or wishes to stand back from the auction and assess the position. These are acceptable reasons but bidders may also use waivers to disrupt the flow of the auction and unnecessarily prolong it. Where a bidder is unable to submit a bid within the round time an alternative to exercising a waiver is for the auctioneer to allow the bidder a round extension. We prefer this option, which avoids the possible disruptive use of waivers.

Transparency

A9.24 Bidders need information on others' bids to help their decision making in the auction. The downside of releasing information on bids is that it can assist collusion between bidders or give strong bidders the opportunity to indulge in aggressive tactics designed to discourage weaker bidders.

A9.25 In order to bid sensibly bidders need some information on activity during each round. There are a range of options for releasing information to bidders in an SMRA, including for example, releasing the number of bidders active in a round or comprehensive information about the number and amount of bids on each lot.

Bidders could also be given information to enable them to monitor the identity of all other bidders and the bids they made. In addition, bidders could receive information about each bidder's initial eligibility and changes in eligibility on a round by-round basis.

Electronic bidding

A9.26 An SMRA, to be managed efficiently, will be run electronically allowing remote bidding over the internet.

Annex 10

Examples of bidding document

Example bid form: Amy in round 2

OFFICE OF COMMUNICATIONS

Auction of Wenvoe licence

Channel 51 (710MHz-718MHz)

Round 2 in progress

Round 2 will close today at 16.30

Enter your bid on the form below and click on the **Check bid** button at the bottom of the page to check the validity of your bid. You will then be presented with a summary, and if your bid is valid, given the option to submit your bid by clicking on the **Submit bid** button. You have not submitted a bid until you have clicked on the Submit bid button and received an acknowledgement from the system.

Your previous bid amount: **£ 35,000**

New bid amount: **£ 49,000**

Please enter your bid decision:

- ● **Accept the new bid amount**
- ○ **Reject the new bid amount**

If you reject this bid amount, you may enter a maximum bid, which must be greater than £35,000 and less than £49,000

Your maximum bid amount: £

Check bid

Example bid form: Ben in round 4

OFFICE OF COMMUNICATIONS

Auction of Wenvoe licence

Channel 51 (710MHz-718MHz)

Round 4

Round 4 will close today at 16.30

Enter your bid on the form below and click on the **Check bid** button at the bottom of the page to check the validity of your bid. You will then be presented with a summary, and if your bid is valid, given the option to submit your bid by clicking on the **Submit bid** button. You have not submitted a bid until you have clicked on the Submit bid button and received an acknowledgement from the system.

Your previous bid amount: £ 59,000

New bid amount: £ 71,000

Please enter your bid decision:

○ **Accept the new bid amount**

● **Reject the new bid amount**

If you reject this bid amount, you may enter a maximum bid, which must be greater than £59,000 and less than £71,000

Your maximum bid amount: £ 69,002

Confirm bid

Annex 11

Protection clause

Introduction

A11.1 This Annex sets out the matters we considered in relation to the protection clause for the geographic interleaved spectrum awards. We have proposed that such a 'protection clause' is included in the licences to be awarded for the cleared spectrum[54]. However, the lots of geographic interleaved spectrum that we are proposing to award for new DTT services will be tightly defined using the UKPM and a fixed set of interference entries into existing DTT services. In this case no additional protection is required into the existing DTT multiplexes and we do not, therefore, propose to include a protection clause in the licences for this award, as set out in section 8.

A11.2 For new services other than DTT in the geographic interleaved spectrum, there may be less certainty as to the interference entry into existing DTT services. In this case an additional protection clause will be included to ensure that existing DTT are protected

Protection of the existing DTT multiplexes

A11.3 The existing DTT multiplexes are broadcast from a fixed network of transmission sites across the UK. Three of these multiplexes (the public service multiplexes) carry public service content (such as BBC and ITV services) and will be broadcast from 80 medium to high power transmission sites and over 1,000 low-to-medium power relay transmission sites. The public service multiplexes are required by their licences (and in the case of the BBC its Royal Charter) to match the coverage of the existing analogue terrestrial network.

A11.4 Our research has concluded that analogue services are available to 98.5 per cent of UK households for roof-top reception. The UK's digital switchover plan (as prepared by the JPP) has therefore allocated suitable frequency assignments (based upon the outcome of the GE-06 conference) to the public service multiplexes that, it is predicted, would enable them to match this coverage post-switchover.

A11.5 The three remaining multiplexes are operated on a commercial basis and do not have any specific coverage obligations in their licences beyond the requirement not to reduce their existing coverage at switchover. The UK Planning Model (UKPM) predicts that the existing multiplexes currently cover around 73 per cent of UK households from 80 transmission sites.

A11.6 The commercial multiplex operators have indicated to us that they do not intend to adopt additional sites at switchover but that they will adopt the maximum power possible at these sites at switchover. The JPP has optimised the UK switchover plan to implement this and it is currently expected that they will collectively cover just over 90 per cent of UK households following switchover.

A11.7 It is possible that any new services that are deployed in the any DDR spectrum close to the channels used for these post-DSO DTT transmissions could interfere

[54] See section 5 of the Cleared consultation, http://www.ofcom.org.uk/consult/condocs/clearedaward/condoc.pdf

with their reception. In some cases, this interference may be sufficient to prevent the reception of DTT signals in areas where they are planned to occur.

A11.8 Given the coverage obligations imposed on the PSB DTT providers and our desire to maximise commercial multiplex coverage across the UK, together with their need to operate from fixed sites and tightly defined transmission parameters, it is appropriate to consider a high level of protection for existing PSB and commercial DTT services. Hence, taking this into account and our duties to secure optimal use of the radio spectrum, we might expect to employ more stringent or additional protection measures than would normally be the case.

A11.9 We considered a protection clause which places an obligation on the licensee, in the first instance, to avoid interference in light of the post-DSO DTT coverage plan but if interference is caused, to remedy any case where DTT reception is disrupted. This appears to us as being an effective way of balancing our duties for the following reasons.

- For the broadcasters it offers protection of DTT reception from all neighbouring licensees. If interference is caused, it places the obligation to remedy the interference, in an appropriate and flexible manner, on those creating the interference.

- For those deploying new services in the interleaved spectrum it enables them to deploy networks efficiently and to utilise the radio spectrum close to DTT, in frequency and geographic terms. As the DTT network and the coverage it provides are defined and the transmission sites are fixed, it is possible to provide a clearly defined plan against which interference can be controlled. This offers new service providers certainty in knowing what they must protect. This gives them the ability to roll out networks and avoid causing interference. If interference is caused to DTT reception they have the choice of adjusting their transmissions to restore the situation (for example by reducing the power of transmissions or by moving the equipment elsewhere) or of remedying the reception of those affected (for example by installing superior reception filters to those affected).

- For new DTT services in the geographic interleaved spectrum, the UKPM intrinsically provides protection for existing DTT services from new DTT services transmitting from existing DTT sites. Therefore, where the geographic interleaved spectrum is used for DTT services, which we consider likely, there is no need to include additional protection in the form of a protection clause.

A11.10 However, should services be deployed from locations that are one of the existing DTT transmission sites, receivers of existing DTT services in the immediate vicinity of the transmission site could suffer interference and may need protection. Similarly, the variation of a licence to a different (and at present unknown) use may lead to interference into incumbent DTT. Any changes to the transmission site or other technical parameters would require a variation of the licence, and Ofcom would consider inserting a protection clause in the relevant licence, at the time of variation.

A11.11 Interested parties considering services other than new DTT services in the interleaved spectrum should read Annexes 7 and 8 of the cleared consultation document[55].

[55] http://www.ofcom.org.uk/consult/condocs/clearedaward/

Annex 12

Promoting competition and efficiency – further analysis

Introduction

A12.1 As discussed in section 10, we have taken a three step approach to promoting competition and efficiency.

- The first step involves using auction design and packaging to try to set the foundations for a well functioning market, and bring about (where relevant) a market structure which furthers competition.

- Step two of the approach involves considering whether there is a need for general safeguards to provide spectrum holders with sharper incentives to use spectrum efficiently and to promote competition through bringing about a more competitive market structure. These safeguards would apply to all spectrum holders irrespective of the use to which they put the spectrum. These remedies would generally involve imposing regulatory judgement on the outcome of a market and can impose significant costs if this judgement proved to be incorrect. As a result, we need to consider the costs and benefits of these interventions carefully before deciding to act.

- Step three of the approach involves considering whether there are specific award outcomes that have a significant likelihood of resulting in market structures that fail to promote fully competition and efficiency. In any such situation we would need to consider the specific issue and whether or not specific remedies – above and beyond those considered or imposed in steps one and two – might be required. In considering any such remedies we would need to have regard to their effectiveness and potential costs, such as the risk of unintended consequences.

A12.2 We discuss the application of step one in section 10. In that section we also summarise the outcome of our application of the next two steps. In this annex we set our analysis of the issues involved in applying these two steps in more detail.

General remedies under step two

A12.3 We set out here our consideration of possible general remedies under step two, as part of our discussion of our approach to competition and efficiency issues set out in section 10.

Use it or lose it requirements

A12.4 These conditions would be included as conditions in the licences to be awarded. Under them, spectrum owners could be required to give up their rights to spectrum if they were found to be not in use, or alternatively take action to address the underutilisation concerned. This potentially addresses any risk of inefficiency arising from speculative spectrum hoarding or from users holding spectrum idle for other reasons, and this resulting in inefficiency of spectrum use and/or a failure to fully promote competition.

A12.5 These conditions might be effective and hence beneficial in situations where it is clear that two conditions were met: that the spectrum was being held idle; and that such idle holding was inefficient. However, there are a number of drawbacks with these conditions. These include the following:

- It may in practice be difficult to define and so detect where spectrum is used or not. It is likely, for example, that spectrum owners will use their spectrum holdings for some purpose, even if it is not to the fullest extent possible. Additionally, spectrum owners may in any case be able to find ways of circumventing use it or lose it rules by for example finding limited and temporary uses for their spectrum.

- Use it or lose it requirements may foster rather than correct for inefficient spectrum use. In some situations it may be efficient for firms to hold spectrum idle, perhaps for sustained periods. For example, a firm may have judged it better not to use the spectrum while waiting for a particular market uncertainty to be reduced. Forcing spectrum use in such cases might encourage early and inefficient investment in particular services or markets.

- Use it or lose it conditions may also act as a significant barrier to efficient trading, where trading is predicated on a change of use or on a use which requires the spectrum to be unused for a period.

A12.6 Taking these considerations into account, we do not propose to introduce use it or lose it requirements into the licences made available in the geographic interleaved spectrum. This is because we think that the benefits of using this remedy are likely to be limited whilst the costs could be significant given the difficulty of detecting when idle spectrum is inefficient, which is particularly likely to be relevant here given the market uncertainty faced by some of the potential users of the geographic interleaved spectrum.

Rollout obligations

A12.7 These generally involve a licence condition which places an obligation on a licensee to rollout a network and services to cover a defined proportion of the UK population. The purpose of this remedy would be to ensure that service coverage is widespread across the UK, even in areas which may not be commercially attractive, in order to ensure both that spectrum is utilised and that citizens in these areas receive benefits.

A12.8 As mentioned above, the key purpose of this remedy is to ensure that networks and services are rolled out in areas where it may not be commercially attractive. Therefore, this remedy is likely to impose costs on spectrum holders and hence could make entry commercially unattractive in some situations. Alternatively, if entry still occurs, the remedy forces a cross subsidy which is paid for by other consumers, thus distorting the markets concerned.

A12.9 Therefore, this remedy should only be considered when there is evidence that the benefits of the additional rollout which it secures are likely to exceed the costs. However, even in this situation, a rollout obligation may not be the most cost effective approach to achieving the desired level of rollout. For example, where the service could also be provided through other means (i.e. over fixed infrastructure rather than by using spectrum or through alternative spectrum), such obligations risk distorting the provision of the service in a commercial and cost-effective manner, since they may impose additional costs on service providers and hence their wider consumer base. In such situations, as we set out in our DDR statement, a more efficient approach is typically to fund provision of the desired additional services directly, with funding coming from bodies tasked with delivering or procuring relevant public benefits. Such an approach would ensure that the socially desirable level of rollout is achieve while allowing flexibility in how services are provided in different areas; it may be the case for example that different blends of inputs (spectrum at different frequencies, or different blends of spectrum and fixed infrastructure) deliver the same overall service at lower costs in different areas.

A12.10 In the DDR statement we considered whether there was evidence to suggest that a market failure could result from the citizen benefits of additional rollout being ignored by spectrum holders. We did not find evidence to suggest that this form of market failure would occur as a result of the geographic interleaved award, given the way in which geographic interleaved spectrum may be packaged and used. Additionally, as discussed above, even if this form of market failure were to occur we do not think that a rollout obligation would be the appropriate remedy, as direct funding can achieve these benefits in a more cost effective manner.

A12.11 Hence, we do not propose to introduce rollout conditions in the spectrum licensees to be awarded.

Information provisions

A12.12 The public availability of information regarding spectrum in the market and the uses to which it is being put can be very helpful in enabling existing and prospective spectrum owners to gauge the relative value of spectrum in relation to other inputs and so make efficient purchasing and production decisions, including within secondary markets for spectrum. Currently the availability of this information is relatively limited.

A12.13 The scope and nature of information that is most helpful for promoting efficient spectrum use and secondary markets will, at a high level, be concerned with the volumes and frequencies of spectrum awarded and the extent to which it is being used, so enabling a view to be taken on the amount of spectrum which is potentially available for other uses which may emerge in the future.

A12.14 In response to concerns about the limited availability of such information, we have decided to include in the 2.6 GHz award[56] a standard condition in the licences for the 2.6 GHz and 2010 MHz bands which requires licensees to provide us, on request, with general information regarding their equipment and use of frequencies, or the rollout of their network. We further noted that we may from time to time publish aggregated information received on the number of base stations and frequencies used in areas across the UK, in order to help secure optimal use of the spectrum and facilitate trading.

A12.15 We consider that such an approach could have general merit in respect of the geographic interleaved award (and in the cleared award). The form such a condition might take is discussed in section 10. We think that the costs of the approach are limited. However, we note that in adopting any such approach one concern would be the need to recognise appropriately any commercial confidentiality concerns that the public release of certain data might raise. Conversely, we think that the benefits of the approach are potentially significant. This is because, given the likely importance and scarcity of the geographic interleaved spectrum, inefficient

[56] See http://www.ofcom.org.uk/consult/condocs/2ghzrules/statementim/statement/statement.pdf

spectrum use, even for relatively short periods of time, could impose significant costs on UK citizens and consumers.

Access requirements

A12.16 Where the control of spectrum is concentrated in a few hands, with the consequent potential to result in a market structure in which competition could be further promoted, it may be helpful to require spectrum holders to make the spectrum available in some manner to third parties; i.e. to impose access requirements. This could in some situations promote downstream competition. Forms of access conditions have been proposed and used for example in the recent auction for 700 MHz spectrum held in the United States of America by the Federal Communications Commission (FCC). The exact form of condition that may be most effective will depend on the circumstances under consideration.

A12.17 The manner of access requirements can vary, in that they can be tied to one or more elements of service or asset under the control of the licensee. At a most basic level, access could be given to the spectrum itself, on specified terms. On the other hand, access could be given to services which are provided using spectrum, or to other inputs (apart from spectrum) required for the service. For example, it could involve access to the network, so implicitly including necessary infrastructure such as towers and transmitters, or to wholesale services such as roaming.

A12.18 Access conditions can be advantageous when they allow a spectrum auction to arrive at a more efficient outcome even when this might not appear directly to promote competition in downstream markets. This type of situation may arise, for example, when the efficient use of spectrum requires a small number of networks to be deployed and hence the emergence of relatively concentrated market structures at the network level (as the spectrum required per network is large compared to the available spectrum), but when the provision of these services to end users in a downstream markets can efficiently support a larger number of players (i.e. a less concentrated downstream market structure).

A12.19 These conditions tend to be most effective where the requirement for downstream access to wholesale services or spectrum is clear cut and where access conditions can be tailored to the circumstances.

A12.20 Nevertheless, even in these circumstances, access conditions can be complex to specify and difficult to implement effectively. For example, it may be necessary to specify the terms on which access is to be provided. This requires careful assessment of the costs that the wholesale provider incurs in providing wholesale access and the impact of this on the incentives of the provider to develop or improve services. Terms which are too generous to the downstream players for example could risk unintended consequences such as a relative lack of investment in network services by the wholesale provider.

A12.21 Bearing in mind both the potential uses and fragmented geographic nature of spectrum in the geographic interleaved awards it is not at all clear that a general access remedy would be appropriate. This is for the following reasons:

- A likely use for geographic interleaved spectrum will be DTT broadcasting. The form of broadcasting applications will depend on award outcomes; it may be the case for example that geographic interleaved spectrum is used for a number of metropolitan type local or regional services. In this case, access requirements are unlikely to promote competitive outcomes and could risk discouraging bidder participation. We do not consider that it is appropriate therefore to design and impose some form of general access requirement even where we have some degree of knowledge about the likelihood of the broad application.

- There are in addition a variety of potential other uses of the geographic interleaved spectrum and associated possible downstream markets. The form and hence benefits of a general access requirement are therefore hard to see; it is not at all clear that one form of access requirement would facilitate all possible types of downstream competition. Conversely, the costs and unintended consequences of this approach might be significant; onerous or inappropriate access conditions could distort interest and the market for spectrum.

- Access conditions are generally more suitable for facilitating competitive downstream market structures in specific situations (when the terms of access can be tailored to the particular problem). This is because access conditions may be expected to be more effective where they are targeted at specific issues when there is a clear cut case for downstream market players to be provided access to the wholesale services afforded through use of spectrum.

A12.22 Overall we do not think there is a case for applying a general access condition to all of the potential uses of the geographic interleaved spectrum. Access conditions can have significant unintended consequences, and hence should only be applied when there is a strong case for access being required to further promote competition or efficiency. There is no such requirement which applies generally to all of the potential uses of the geographic interleaved spectrum. Therefore we think that the benefits of general access conditions, which apply to all uses, are limited and the costs are potentially significant. The specific issues raised by the potential acquisition of geographic interleaved spectrum by individual potential bidders such as Sky and NGW/Arqiva are considered separately under our analysis of step three (both below and in section 10).

Spectrum caps

A12.23 Spectrum caps work by limiting the amount of spectrum that an individual party may hold. Their purpose is to promote diversity of spectrum holdings (i.e. to guard against outcomes where the award results in a very small number of players holding all of the spectrum), and hence facilitate the emergence of more competitive market structures which can help to foster efficient spectrum use.

A12.24 We set out below the forms spectrum caps might take, whether or not there might be a case for applying a general spectrum cap in respect of geographic interleaved spectrum, the advantages and disadvantages of this approach, and our conclusions.

A12.25 Spectrum caps can take a variety of different forms:

- Spectrum caps can be set as an absolute limit on the amount of spectrum any one party can hold (i.e. a hard spectrum cap), or can be set such that if the cap is exceeded, there are other conditions which may apply to the spectrum licence such as a different initial licence period (i.e. a soft spectrum cap).

- Spectrum caps can be set either loosely or tightly. A loose spectrum cap involves setting a cap at such a level that it has only limited impact on the uses to which the spectrum can be put by an individual party, but with the intention of being a general safeguard to prevent spectrum holdings becoming heavily concentrated.

A tight spectrum cap aims at constraining the structure of spectrum holdings and use more severely, and might be used where there are significant concerns that absent such caps there is a likelihood that more competitive market structures might fail to arise.

- Spectrum caps can either be set without reference to other spectrum holdings or can be set to take into account spectrum holdings across other spectrum bands. In this discussion we call the first type 'non-contingent' caps and the second type 'contingent' caps.

- Spectrum caps might be set to apply at the time of the award of spectrum only (e.g. each bidder in the auction might be restricted to a maximum purchase level) with no restriction on subsequent secondary market trades and holdings. Alternatively they might be set at the time of the award and endure afterwards.

A12.26 Spectrum caps are relatively simple to understand and implement. They are also likely to be effective in promoting a diversity of spectrum holdings and more competitive market structures both in the general sense and where a more targeted approach is required.

A12.27 However, for these benefits to be realised without undue costs requires careful judgement about the size and nature of the spectrum cap. Inappropriately tight caps for example risk eliminating spectrum award outcomes that would otherwise have been efficient. Given the size and nature of potential consumer and citizen benefits from spectrum use, the costs of any such distorted outcomes could be very significant. Alternatively inappropriately loose caps risk failing to have an effect and so failing to promote sufficiently more competitive market structures they are intended to.

A12.28 The nature of the cap which may be appropriate, and its costs and benefits, will depend upon the competition and efficiency considerations to be addressed by the remedy.

A12.29 For the cleared award, we concluded that it may be appropriate to apply a general safeguard cap of 50 MHz. Such a cap would provide an absolute limit on the amount of spectrum that any one party can acquire in the cleared award auction. It would be a cap that only applied at the time of the award, in that it would only limit the amount of spectrum which could be acquired in the at the time of the award, so that after the award individual licensees (including speculative licensees) could build larger holdings via the secondary market if this represented the most efficient market outcome.

A12.30 We reached this conclusion for the cleared award for the following reasons:

- It would promote diversity of spectrum holdings, and so help to promote more competitive market structures.

- Provided it was set at a reasonable level, it would not, we believe, unduly constrain the potential uses of the cleared spectrum, and hence would not impose significant costs.

- The cap was proposed to be set out at a level which would amount to around 40 per cent of the national cleared spectrum available, sufficient for example for a single winner to deploy a full national multiplex using a multi-frequency DTT network or deploy a national mobile broadband network which supported high data rates.

A12.31 For the geographic interleaved award, we have considered whether or not a safeguard spectrum cap might offer similar benefits, either as a standalone cap within interleaved geographic spectrum itself, or by extending the scope of the proposed 50 MHz safeguard cap to include geographic interleaved spectrum in some way.

A12.32 In the case of a standalone spectrum cap for geographic interleaved spectrum, we do not see strong benefits of such an approach compared with potential downsides. This is for the following reasons:

- The effective frequency range likely to be awarded at any one location is rather narrow in comparison to the cleared award; assuming that two single channel lots are offered at any one transmitter site, our packaging proposals would imply a frequency range available for auction of 16 MHz in any location. Hence the scope for and benefit of diversity of holdings at each location will be limited.

- Similarly, imposing a spectrum cap that limits holdings to any fraction of geographic interleaved spectrum available at any location could be costly. This is because it would risk limiting the uses to which the spectrum might be put in each area and so has the potential to result in lost economic opportunities. Conversely setting a spectrum cap on a frequency basis at a level higher say at 16 MHz is unlikely to have any effect on bidding behaviour or award outcomes given our packaging proposals.

- Alternatively, setting the cap by restricting the total number of geographic interleaved lots that may be purchased by any one party (i.e. capping the holding of spectrum in geographic rather than frequency terms) would similarly risk unduly restricting possibilities for aggregating lots to achieve a particular geographic footprint of service coverage or to some extent substituting lots, with consequent risks for inefficient allocation outcomes.

- Our proposal to phase the award of geographic interleaved in a series of processes means that the imposition of some form of cap on all the auctions would introduce difficulties and possible inefficiencies in respect of bidders who were looking to acquire spectrum over all the phases. A cap might for example inappropriately deter some bidders from acquiring spectrum in an earlier phase.

A12.33 Accordingly, the benefits of a safeguard cap for geographic interleaved spectrum in isolation are likely to be limited and the risks and costs potentially large.

A12.34 We also consider at this stage that it will also not be appropriate to extend the scope of the 50 MHz safeguard cap proposed for the cleared spectrum to include geographic interleaved spectrum contingent on cleared award outcomes. This is for the following reasons:

- The spectrum cap proposed for the cleared award is intended to be a general safeguard cap aimed at promoting a diversity of spectrum holdings. For example by guarding against outcomes where spectrum holdings are heavily concentrated. Hence, we believe that the proposed cap in the cleared award is likely to be sufficient to achieve our goal. Extending the cap into the geographic interleaved award could further promote diversity, as it could prevent the outcome of a bidder who acquired cleared spectrum up to the level of the proposed cap also acquiring a significant proportion of geographic interleaved spectrum. However, we do not think there would be sufficient additional benefits from using a safeguard cap to prevent this outcome, given the potential costs (as discussed below). This is because if this outcome were to arise, we think there would be a sufficiently diversified outcome (i.e. given the level of diversity provided for by the 50 MHz cap this is unlikely to result in an outcome where spectrum holdings are too heavily concentrated).

- Additionally, we think that extending the cap could impose costs. This is because it may limit the opportunities for bidders to acquire spectrum in the geographic interleaved award to complement their acquisition of cleared spectrum (as discussed in section 4).

- Finally, our proposal to auction the spectrum in a series of awards could, in combination with an extended cap, introduce a further constraint on bidder options over the course of all the awards, and so introduce a further source or risk and uncertainty for bidders. Under such circumstances a bidder for example might feel unduly constrained from purchasing spectrum in an early award in order to minimise the chances of breaching the spectrum cap following the outcome of the subsequent awards. Such constraints risk unduly distorting award outcomes.

A12.35 For these reasons, we do not at this stage see a strong case for extending the scope of a general remedy of a 50 MHz safeguard cap, of the form proposed for the award of cleared spectrum, to the award of geographic interleaved spectrum. Nevertheless we remain open to views on this issue.

A12.36 In summary, we do not at this stage consider that a spectrum cap in respect of the geographic interleaved award, either on a standalone basis or linked in some way to the general 50 MHz safeguard cap proposed for the cleared award, is necessary.

Specific issues under step three

A12.37 As set out in section 10, our assessment of possible spectrum award outcomes and the potential for these to result in market structures which could be more competitive highlights that, in most cases, we concluded that any concerns about the likely market structure were not sufficiently significant to warrant further consideration.

A12.38 However, our assessment identified two particular issues for which we consider that there is sufficient potential for the market structure to be less competitive than it might otherwise have been. We set out here our consideration of these two specific issues, including our assessment of whether these possibilities merit some form of explicit intervention in the award of geographic interleaved spectrum.

Sky on DTT

A12.39 The potential acquisition and aggregation of geographic interleaved spectrum by Sky in order to launch pay TV services on the DTT platform could result in principle result in a market structure which fails to fully promote competition. The scale of this effect would be related, among other things, to the coverage any acquisition of geographic interleaved might provide. As we noted in section 4, coverage provided through geographic interleaved spectrum could be limited in comparison to that provided under cleared spectrum in a number of channels.

A12.40 However, other considerations are also relevant. Within the last year we have published two consultation documents which are relevant to this assessment. These are firstly, the Pay TV market investigation[57] and secondly, our assessment[58] of Sky's proposal to remove the three free to air channels that it currently provides on the DTT platform and replace them with pay TV channels (often known as Sky's 'Picnic' proposal). We have not reached definitive conclusions on the issues considered in either of these documents, which acknowledge competition concerns raised at various levels of the supply chain for pay TV services. However, our analysis here takes into account the issues identified in these documents in relation to the potential for Sky to have market power, primarily in relation to the potential existence of any wholesale markets for premium content (likely to include first run Hollywood movies and particular types of sports content), and the possibility for this market power, if it exists, to be leveraged into other markets, and as a result for the potential for more competitive market structures to be forgone.

A12.41 If Sky does have market power over wholesale markets for access to premium content, then it is possible that an acquisition of sufficient geographic interleaved spectrum, coupled with this control of premium content, could raise competition concerns such as:

- the potential to foreclose further development of competition in terrestrial broadcasting; and
- the potential to leverage any possible market power arising from control of premium content into retail markets across platforms.

A12.42 Both of these effects, were they to occur, could prevent the emergence of more competitive market structures and might not further the interests of consumers. However, in order to assess whether these effects raise a competition concern which we should seek to address through the geographic interleaved awards, we need to consider carefully the source of the concern.

A12.43 A key driver of the concern is, as highlighted above, the extent to which Sky has control over any wholesale markets for access to premium content. The less access that other providers have to such premium content, all other things being equal, the greater the extent that Sky may be able to act independently in terms of pricing and leverage in pay TV markets across all platforms, including any established through the creation of one or more further DTT multiplexes using the digital dividend spectrum. However, this concern is not directly linked to the impact of a potential acquisition of geographic interleaved spectrum by Sky and its result on the market structure which might emerge.

A12.44 A second relevant driver is the extent to which, were Sky to rollout a further DTT multiplex to offer its services, other pay TV participants or potential entrants might have access to other DTT capacity and so be able to bring about more competitive market structures. We note that some potential exists for the digital dividend to yield more than one multiplex. Additionally, there is the potential for existing capacity on the DTT platform to be upgraded and expanded in the future. To the extent that such capacity is offered to market by the existing DTT multiplex operators on a comparable timescale to Sky's potential acquisition of digital dividend spectrum, other pay TV market participants or potential new entrants could also use this to enter the platform and act as a competitive constraint at that point. However, it may

[57] See http://www.ofcom.org.uk/consult/condocs/market_invest_paytv
[58] See http://www.ofcom.org.uk/consult/condocs/dtv/

be the case that Sky's market position in relation to premium content could limit the ability of new entrants to compete effectively through either of these routes.

A12.45 Overall, we see the question of access to premium content as the central issue in relation to the potential for there to be competition concerns arising in relation to Sky's market position. This issue is not primarily linked to the potential for Sky to acquire geographic interleaved spectrum, or to the impact this might have on market structure. To the extent that other issues have been raised regarding competition concerns in the provision of pay TV services, we similarly do not believe that these would suggest a case for intervention in relation to the potential for Sky to acquire geographic interleaved spectrum. Additionally, we recognise that any concerns arising from the potential for Sky to acquire geographic interleaved spectrum is likely to be less than the concerns which may arise from a potential acquisition of cleared spectrum by Sky, given the more limited coverage afforded by geographic interleaved spectrum.

A12.46 These considerations would suggest that any competition concerns are best pursued through our existing initiatives concerning 'Picnic' and our wider review of the pay TV market. However, we recognise that we may need to keep this under review.

NGW / Arqiva

A12.47 The geographic interleaved spectrum could be used to rollout additional DTT multiplexes, which could be used to provide wholesale multiplex capacity services. Again we note in this context that the coverage provided through geographic interleaved spectrum could be limited in comparison to that provided under cleared spectrum in a number of channels, and that this will tend to reduce the utility of any such services compared to what might be achieved through the cleared spectrum.

A12.48 Competition in the provision of wholesale services on the DTT platform is an issue which was considered briefly in the context of the acquisition by Arqiva's owner Macquarie of NGW. Here we consider the potential impact of the merged entity acquiring geographic interleaved spectrum in order to create and operate additional DTT multiplexes, and as a result, increasing its market share at the multiplex layer in the value chain and hence impacting on the resulting market structure.

A12.49 The main elements of the DTT supply chain are set out in the table below.

Table A12.1 DTT supply chain

Value chain layer	Description of the services provided
Transmission provider – In relation to DTT NGW and Arqiva provide all Managed Transmission Services (MTS) and Network Access (NA)	MTS - a package of services including some or all of network design, procurement and installation of transmitters, network monitoring, quality assurance of the signal and maintenance of the transmission equipment and procurement of Network Access.
	NA - a package of services as defined as providing access to transmission sites and infrastructure including masts, antenna, combining units (if required), on site buildings and access to utility services. NA contracts can

	include the design and installation of specific equipment including new antenna.
Multiplex owners – there are currently six multiplexes operated by the following organisations: Multiplex / Licensee 1 – BBC 2 – Digital 3&4 (ITV/Channel 4) A – SDN (ITV) B – BBC Free to View Ltd C – NGW D – NGW	DTT is delivered by multiplexing a set of channels that are then broadcast. There are six existing multiplexes. One of these (Multiplex 1) has been allocated by the government to the BBC under its Charter and Agreement. The remainder are licensed by Ofcom to the corresponding licensee. Each multiplex operator (licensee) therefore in principle acts as a gate keeper to spectrum currently necessary for DTT. Multiplex owners acquire MTS from a transmission provider (who in turn will need to ensure they have appropriate NA Agreements with the site owner).
Broadcaster – there are currently in the region of 35 television channels broadcast over the DTT platform	Broadcasters acquire multiplex capacity from multiplex operators. Their services include capacity on a multiplex which is broadcast from a number of transmission sites.
Viewer reception – there are in the region of 17 million TV sets capable of receiving DTT services	Viewers access the channels broadcast over the DTT multiplex though an aerial and a digital ready television (IDTV) or a set-top box, which decodes the services.

A12.50 As indicated in the table above, both MTS, excluding spectrum, and NA are subject to ownership and control by Arqiva and NGW. In April 2007, Arqiva's owner Macquarie UK Broadcast Ventures Limited acquired NGW.

A12.51 In view of possible competition concerns arising from this, the completed acquisition was referred to the Competition Commission (CC) in August 2007. The CC found, among other things, that the acquisition could be expected to lead to a substantial lessening of competition in the provision of MTS/NA services. After consideration of relevant potential costs and benefits of the acquisition, the CC in March 2008[59] approved the acquisition, subject to the successful negotiation of a number of behavioural undertakings. If undertakings are not agreed, a partial divestment is likely to be required. In the meantime NGW operates as a separate economic entity under hold-separate undertakings.

A12.52 At the platform layer, as indicated above, there are six multiplexes which are ultimately controlled by four different parties (the BBC, Digital 3&4 (joint venture

[59] See Competition Commission's final report at http://www.competition-commission.org.uk/rep_pub/reports/2008/fulltext/537.pdf

between ITV[60] and Channel 4), SDN (owned by ITV plc) and NGW). Three of these multiplexes (A, C, D) are referred to[61] as 'commercial multiplexes'; that is, their multiplex operators do not carry any public service content and are not under any regulatory requirements to achieve specific levels of coverage. The capacity on these multiplexes is therefore available to parties interested in purchasing services. These operators are required to make this capacity available on fair, reasonable and non-discriminatory terms. The other three multiplexes (1, 2 and B) are referred to as 'PSB multiplexes'. These have an obligation to match the coverage of the existing analogue terrestrial networks (estimated as being 98.5% of UK households) and are used to carry PSB channels. Therefore, NGW currently controls two out of the three multiplexes used to provide services to non-PSB broadcasters.

A12.53 A scenario that could arise as a result of the cleared and geographic interleaved awards is the acquisition by the merged NGW/Arqiva of spectrum for use for one or more further commercial DTT multiplexes, including for example the possibility that a multiplex created through the acquisition of geographic interleaved spectrum is an addition to one acquired through the cleared spectrum. This could in principle significantly increase the share this entity has of the provision of multiplex services to commercial broadcasters.

A12.54 However, the impact of this will depend upon whether other wholesale broadcasting services – either multiplex capacity provided on PSB multiplexes, or wholesale platform services provided on other technology platforms - compete with those offered by NGW/Arqiva. For example, a party seeking broadcast services might in principle be able to find other entities that can provide these services, either via alternative access to terrestrial DTT platform through PSB multiplexes, or through broadcast services provided on other technology platforms. Both routes might ensure more competitive market structure to emerge even in the case where NGW/Arqiva had increased its share of commercial multiplex capacity. We further note that the nature of the geographic interleaved spectrum available would not necessarily afford NGW/Arqiva full UK coverage (even if such coverage was required commercially).

A12.55 Given the uncertainties over the likelihood and scale of any potential competition concern which could arise, it is not clear to us that an acquisition of a combination of cleared and geographic interleaved spectrum by NGW/Arqiva would give rise to sufficient concerns to suggest intervention in the award of the geographic interleaved spectrum. And even if we were to have such concerns, these would need to be set in the context of the costs and risks of any effective remedies.

A12.56 If there were to be significant competition concerns, an effective remedy implemented through the geographic interleaved award would be to prohibit or limit the acquisition of digital dividend spectrum in the auction. We think this form of remedy would be undesirable as it would have a number of possible unintended consequences such as:

- the loss of opportunities that such acquisition might afford for economies of scale or scope; and

- a missed opportunity to allow enhanced coordination abilities. An additional multiplex may give NGW/Arqiva an improved ability to coordinate fully and efficiently decisions, when decisions are required at the level of part or all of the

[60] Channel 3 licensees
[61] In the context of DSO

DTT platform (i.e. when deciding upon whether and/or how to upgrade further or expand the platform).

A12.57 Given the uncertainty over whether a competition concern would arise (i.e. whether a market structure which fails to fully promote competition could emerge) and the significant risks involved in seeking to remedy this through limitations on spectrum acquisitions by particular individual parties in the geographic interleaved award, we take the view at this stage that it would be both disproportionate and create risks of unintended consequences if we were to intervene further in relation to the potential for NGW/Arqiva to acquire geographic interleaved spectrum. As a separate issue, we note that in the case that any anti-competitive behaviour were to arise, we would be able to seek to resolve this through our regulatory or competition powers as appropriate.

Annex 13

Impact Assessment

Introduction

A13.1 The analysis presented in this annex represents an impact assessment, as defined in section 7 of the Communications Act 2003 (the Act).

A13.2 You should send any comments on this impact assessment to us by the closing date for this consultation. We will consider all comments before deciding whether to implement our proposals.

A13.3 Impact assessments provide a valuable way of assessing different options for regulation and showing why the preferred option was chosen. They form part of best practice policy-making. This is reflected in section 7 of the Act, which means that generally we have to carry out impact assessments where our proposals would be likely to have a significant effect on businesses or the general public, or when there is a major change in Ofcom's activities. However, as a matter of policy Ofcom is committed to carrying out and publishing impact assessments in relation to the great majority of our policy decisions. For further information about our approach to impact assessments, see the guidelines, Better policy-making: Ofcom's approach to impact assessment, which are on our website: http://www.ofcom.org.uk/consult/policy_making/guidelines.pdf

A13.4 We have already consulted on our approach to the award of the spectrum freed up by digital switchover for new uses. Our analysis of the policy options relating to the general approach has been set out in two previous impact assessments, the first as part of our December 2006 Consultation and the second updated version as part of our December 2007 Statement. These assessments included consideration of the approach to the award of both cleared and interleaved spectrum as well as spectrum which was not cleared as a direct consequence of DSO and which is currently used for other services (i.e. channels 36 and 69).

A13.5 The analysis of options undertaken in this first phase of work, and as summarised in the two previous impact assessments, led us to conclude that a market led approach was more likely to meet our objective for the DDR than the alternative, interventionist approach. We found that certain specific measures were justified in the case of two services: PMSE and local television. The measures in respect of local television were to release geographic lots of interleaved spectrum suitable for, but not limited to, this service, which we will award by auction.

A13.6 Having established the approach we will take to the geographic interleaved awards, we now consider the method by which we will award the spectrum. This consultation focuses on the method and process for the auctions of geographic interleaved lots in the bands 470-550 MHz and 630-790 MHz.

A13.7 Two other consultations published in parallel with this document focus on the method and process for the award of:

- cleared spectrum; and
- spectrum to a band manager with obligations toward PMSE.

The citizen and/or consumer interest

A13.8 Our primary duties are to further the interests of citizens in relation to communications matters and to further the interest of consumers, where appropriate, by promoting competition. In the first phase of the DDR, the potential benefits to citizens and consumers were the focal point of our analysis. When deciding between the competing policy options for our approach to the award, we were guided by the total value each one of them could generate for society, including the benefits for consumers, for producers and for citizens.

A13.9 In this, the second, phase of the DDR, we can further improve the outcome of this award of spectrum for citizens and consumers by careful design of the spectrum packages, detailed auction format and rules and the licence terms and conditions. This will involve balancing some key trade-offs. For example, the technical licence conditions must protect existing users of the spectrum, and by extension, the citizens and consumers who use these services, while at the same time maximising its usability for new uses. Also, the spectrum packages should be flexible enough to accommodate the different potential uses, thereby promoting competition and innovation and resulting in more choice, new services and better prices for consumers, while at the same time reflecting the specific constraints that apply to the spectrum.

Our policy objective

A13.10 Our overarching objective in releasing the digital dividend is to maximise the total value to society generated by the use of this spectrum over time.

Options considered

A13.11 There are a number of ways that we can achieve this objective in our design of this award. We can:

- choose appropriate technical licence conditions that consider the need to protect existing users of spectrum while maximizing flexibility for new uses;
- choose appropriate non-technical usage rights which provide certainty of tenure and help to promote efficient outcomes
- design spectrum packages which best reflect the demand for the spectrum and the specific technical constraints on the spectrum;
- design an efficient auction process that promotes competition and encourages bidders to express their true value for the spectrum; and
- consider whether further remedies may be required to ensure that competition and efficiency are promoted through the award and use of the spectrum.

A13.12 For each of these areas, we have considered several options and our full analysis of these options is set out in the consultation document. In the remaining part of this impact assessment, we summarise our analysis in respect of the key issues for the DDR geographic interleaved awards and cross reference this to the relevant sections in the main body of the document.

Analysis of the different options

Choice of technical licence conditions

Type of condition

A13.13 One of the key issues for this award is the type of technical licence condition that should be included in the licences of available spectrum. We have considered two main options:

- Transmit masks (Block Edge Masks)
- Spectrum usage rights (SURs)

A13.14 Table A13.1 sets out a summary of our analysis (these issues are discussed further in paragraphs 8.3-8.7 of section 8):

Table A13.1 Transmit masks or SURs

Options	Advantages	Disadvantages
Transmit mask	Tried and tested Simple to understand Relatively easy to assess compliance Allows for a level of flexibility to deploy different types of service	Restricts ability to optimise power/density trade off in transmission networks Difficult to estimate the expected interference levels from neighbouring licensees, though the narrower range of uses in this award makes this less of a drawback
SUR	Provides a higher level of interference protection and certainty to neighbours than mask-based licences Allows flexibility to deploy different types of service Especially suitable for spectrum where there is wide range of possible uses	More complex to define and compliance assessment is not as straightforward as for mask-based licences

A13.15 In the case of geographic interleaved lots, we believe that the relatively narrow range of likely uses tilts the balance in favour of transmit masks and propose that technical licence conditions should be presented in this form.

Protection options

A13.16 We considered three options for post-DSO protection where there is overlapping coverage. Section 5 and Annex 5 sets out our thinking. We set out our analysis of the options in the following table:

Options	Advantages	Disadvantages
DPSA only	Of 3 options, allows highest coverage level for new services Illustrative economic cost benefit analysis marginally favours this option	Of 3 options, requires highest level of remedial measures and costs required (aerial replacement or repositioning) Does not protect relevant national service; i.e. does not take account of national or regional borders and hence need to deliver appropriate national service to relevant households Does not protect about 100 of the existing analogue relays
Median	Coverage level for new services similar to DPSA option Illustrative economic cost benefit analysis case similar to DPSA only option Affords protection to all transmission sites, including about 100 not covered by DPSA option Can include protection of relevant national service	Slightly higher interference allowed, compared to JPP option
JPP	Remedial costs relatively low	Of three options, coverage levels for new services significantly worse Of 3 options, illustrative economic cost benefit case significantly worst

A13.17 The JPP option offers significantly reduced coverage for new services compared to both the DPSA only and Median options. Although remedial costs are also low under this option, the value of new services is likely to outweigh these considerably and so the reduced coverage gives a significantly weaker economic case to this option overall. Coverage levels for the DPSA only and Median options, and hence economic case, are similar. We see advantages in the Median option affording protection to all transmission sites and for relevant national services and so on balance we favour the Median option.

Non-technical usage rights - interoperability

A13.18 Existing DTT multiplex operators are required to adopt certain technical standards and operating parameters. This means that viewers benefit from receiving a common service across all six existing DTT multiplexes. Given the possibility that interleaved spectrum will be used to deliver new DTT services, we have considered the issue of interoperability with the existing multiplexes and the extent to which regulatory intervention may be needed to secure this. We have identified and analysed three options as set out in Table A13.2 below:

Table A13.2 Interoperability options

Options	Advantages	Disadvantages
Do nothing	Potentially consistent with our duty to regulate only where necessary if no need for interoperability Likely to be benefits (and therefore incentives) for all multiplex operators in interoperating voluntarily to maximise viewer benefits	Not guaranteed to deliver interoperability Our ability to intervene subsequently in favour of interoperability would be limited
Facilitate	Preserves our preference for operators to come to interoperability agreements voluntarily Gives us the ability to intervene decisively if circumstances frustrate such agreements	Does not guarantee viewers the benefits of interoperability across all multiplexes at the earliest possible time
Mandate	Guarantees viewers the benefits of interoperability across all multiplexes	Automatically precludes alternative market offerings that could deliver different, possibly greater benefits to viewers In the absence of a compelling reason to intervene in this way, sits ill with our duty to regulate only where necessary

A13.19 We propose to facilitate interoperability between existing and new multiplex operators at the request of the latter. We consider this option to be the most proportionate response to address the issue as we perceive it.

Packaging

A13.20 For the geographic interleaved auction, we have already stated that we will award one or two packages suitable for but not reserved for local television in about 25 locations with known or likely demand for this use, and that we plan to award lots in respect of locations for three existing RTSL holders (Caldbeck, Winter Hill, and

Wenvoe). The main remaining issue is to decide the extent to which further lots might be auctioned.

A13.21 The question of further lots will primarily turn on the extent to which there is demonstrable demand for lots. Following our January 2008 Stakeholder event, we received expressions of interest for local TV broadcasting which indicated interest in 18 locations and hence lots; 10 of these were already in the list of 25 locations given in our DDR statement. We may receive further expressions of interest.

A13.22 We note in addition that NGW has carried out and we will publish during the course of this consultation technical work on a total of 81 transmitters and hence lots.

A13.23 We have considered four main options for the number of lots to be awarded. These are summarised in the table below and are discussed further in paragraphs 6.3-6.42 of section 6.

Table A13.3 Options for auctioning lots

Option	**Advantages**	**Disadvantages**
1. 3 existing RTSLs and 25 lots given in Statement	- Interest likely in acquiring licence for all locations - Hence reduces chances of unsold lots	- Could restrict possibilities for interested parties to participate - Does not necessarily meet all expressions of interest - Limiting locations substitutes Ofcom for market judgement
2. 3 existing RTSLs and 25 lots given in Statement, *plus* 46 remaining sites out of whole set of 81	- Large set of lots put to auction - Allows market to judge which lots are attractive	- Increased risk of unsold lots and costs of administrating unnecessary auctions - Does not necessarily meet all expressions of interest
3. 3 existing RTSLs and 25 lots given in Statement, *plus* 8 new expressions of interest, *plus* Potential expressions of interest	- Provides opportunity for purchase where there is an expressed demand - Reduces chances of unsold lots	- Need to invite and judge further expressions of interest
4. 3 existing RTSLs and 25 lots given in Statement, *plus* 46 remaining sites out	- Maximizes set of lots put to auction - Provides opportunity for purchase where there is	- Increased risk of unsold lots and costs of administrating unnecessary auctions

of whole set of 81, *plus* 8 new expressions of interest, *plus* Potential expressions of interest	an expressed demand	- Need to invite and judge further expressions of interest

A13.24 Overall, we consider that option 3 best reflects the need to maximize opportunities for interested parties to participate in the auction against the need to minimize unnecessary administrative costs and cost of technical studies associated with putting lots to auction.

Sequencing and timing of the awards

A13.25 For the geographic interleaved award, in determining the timing and in particular whether to hold a series of awards or a single award, we considered the interests of two broad sets of user of geographic interleaved spectrum; those users wishing to purchase a number of lots for aggregation, and those users more interested in one or a few lots, for local use. Bearing this in mind, we identified three basic options for timing of the awards. The table below summarises these, and they are discussed further in paragraphs 6.43-6.45 in section 6. We have sub-divided option 1 into award in winter 2008/09 or in late 2009.

Table A13.4 Options for timing of the awards

Option	Advantages	Disadvantages
1.(a) A single award of all available lots in winter 2008/09	- Releases spectrum onto market as soon as possible - Addresses aggregation risk - Would meet needs of existing 3 RTSLs	- For bidders interested in local lots, may be too early to secure public funding - Short timescale means that in practice this is unlikely be a viable option Threshold risk
1.(b) A single award of all available lots in late 2009	- Addresses aggregation risk - More practicable timetable	- Would require temporary measures for three RTSLs, and extends uncertainty for these operators - Might still be too early for bidders interested in local lots to secure public funding - Threshold risk

2. An award of medium lots for Caldbeck, Winter Hill and Wenvoe in winter 2008/09 followed by a single award of all remaining (large and medium) lots in 2009	- Would meet needs of existing 3 RTSLs Addresses aggregation risk	- Might still be too early for bidders interested in local lots to secure public funding - Threshold risk
3. An award of medium lots for Caldbeck, Winter Hill and Wenvoe in winter 2008/09; a single award in late 2009 of all large lots; and awards linked to the DSO timetable for all remaining medium lots.	- Would meet needs of existing 3 RTSLs - May help to allow bidders interested in local lots to secure public funding in advance of auction - Substantially addresses aggregation risk, for 'aggregatable' lots - Reduces threshold risk	- May limit substitution possibilities between large and medium lots

A13.26 Overall we consider that option 3 meets best our stated commitments and objectives for the award. It allows an efficient simultaneous award of the lots which can be most expected to be complements and substitutes. It recognises that bidders interested in more local and smaller lots may need later award in line with DSO in order to resolve funding uncertainties given that they may wish to secure public funding in advance of the auction.

Auction design for initial phased award

A13.27 We summarise here the auction design options that we have considered for the initial phased award of spectrum; that is, the award in winter 2008/09 of lots for Caldback, Winter Hill and Wenvoe. These options are discussed further in paragraphs 7.1 to 7.67 of section 7. In addition, Annex 7 sets out the factors than can affect the efficient outcome of an auction and possible auction formats. The initial phased award is for three separate lots and we have considered two candidate single unit auction format options: a sealed bid auction or an ascending bid auction. For the reasons set out in Annex 7, we would adopt a second price rule under either format.

A13.28 Table A13.5 sets out the advantages and disadvantages.

Table A13.5 Options for the auction design for initial phase awards

Option	Advantages	Disadvantages
1. Sealed bid auction	- Simple and straightforward	- Does not permit bidders to learn from others during a price discovery

		process
2. Ascending bid auction	- Allows bidders to see development of prices and hence facilitates efficient price discovery	- Slightly more complex than sealed bid auction

A13.29 Given that these items of spectrum have not been subject to market valuation before, and that there might well be bidders with similar business cases who share some degree of common value uncertainty, we think we should place weight on the need for any auction format to facilitate price discovery .This would suggest the use of an ascending bid auction. Although in principle this auction format is more complex than a sealed bid auction, we believe that it is not significantly more complex and that with careful design of the auction process, the process can be made to be relatively straightforward and user friendly from the bidders' point of view. These considerations support the use of an ascending bid auction.

Auction design for combined award and further phased awards

A13.30 For the combined award we have considered that either a combinatorial clock auction (CCA) format or a standard simultaneous multiple round auction (SMRA) format would be suitable, but we have a preference for the former. The reasons for this are set out in paragraphs 7.16-7.27 of section 7. We shall take account of responses to this consultation in deciding which to adopt. We shall consult later in 2008 on our proposal for the format and key auction rules and include an impact assessment in that document.

A13.31 The later phased awards have similarities to the initial phased award discussed above. Although there may be larger numbers of licences available, interest is still likely to include bidders interested in local service provision. We therefore favour an ascending bid auction for each lot to be awarded. The reasons for this are set out in paragraphs 7.29-7.32 of section 7. This proposal is provisional on the outcome of this consultation.

Promoting competition and efficiency

A13.32 We have considered how the award of geographic interleaved spectrum can best promote competition and efficiency in downstream markets. Beyond taking into account the need to promote competition and efficiency through auction design and packaging, we have considered:

- the need for general provisions and safeguards to provide spectrum holders with sharper incentives to use spectrum efficiently and to promote competition. These safeguards would if adopted apply to all spectrum holders irrespective of the use to which they put the spectrum; and

- the risks of specific award outcomes resulting in a less competitive market structure than would otherwise be possible and identifying whether targeting intervention to prevent or resolve these particular outcomes would be an appropriate regulatory response to such risks.

A13.33 Key conditions for considering whether or not to adopt any remedies will be that:

- the remedy can be expected to be effective; and
- the cost of any remedy in terms of regulatory failure or unintended consequences is expected to be significantly outweighed by the significance and likelihood of the competition or efficiency issue.

A13.34 Table A13.6 sets out our consideration of options under general provisions.

Table A13.6 Options for general provisions

Option	Advantages	Disadvantages
Use it or lose it requirements	Effective and beneficial where it is clear that a significant risk exists that spectrum will be held idle and that such idle holding is inefficient	Difficult in practice to define and detect where spectrum is held idle May have unintended consequences where spectrum use is forced in circumstances where it is not efficient to do so Could act as significant barrier to efficient trading
Rollout obligations	Directly increases chances that spectrum is utilised and citizens receive benefits where rollout is not commercially attractive	Implies additional costs on spectrum holders and so may distort primary or secondary purchase of spectrum Other solutions are available to achieve same outcome more efficiently; e.g. direct funding Less relevant to geographic interleaved spectrum where lots are local
Information provisions	Publicly available information regarding spectrum ownership and use facilitates value formation, price discovery and hence efficient spectrum trading Likely to be effective in a range of circumstances and market outcomes	Need to recognise appropriately any commercial confidentiality concerns that the public release of the data might raise
Access requirements	Can be effective in promoting downstream competition in face of upstream scarcity of spectrum, particularly where nature of service and required	Access conditions can be complex to specify and difficult to implement; inappropriate terms could either unduly favour or penalise access provider and have unintended

	access is clear	consequences and costs For geographic interleaved spectrum, not clear what the nature of services to be provided through geographic interleaved spectrum is, hence difficult to specify any general access conditions which apply to potential uses
Spectrum caps	Relatively straightforward to understand and implement Can be effective structural solution, by reducing opportunities for less competitive market structures to emerge following award Can be used in general or specific manner	Requires careful judgement about level in order to minimise risks of unintended consequences Less effective in respect of geographic interleaved spectrum where there is less scope for diversity of ownership at each lot

A13.35 We discuss our approach to general provisions and options in paragraphs 9.34 to 9.66 of section 9.

A13.36 Overall we conclude that one general intervention may be appropriate: an information provision clause that will help facilitate an efficient secondary market.

A13.37 Regarding the risk of specific market failures, we have not identified any specific risks that require specific remedies in respect of the award of geographic interleaved spectrum.

Annex 14

Glossary of abbreviations

3G	Third-generation mobile-phone standards and technology
AIP	Administered Incentive Pricing
BEM	Block-edge mask
BERR	Department for Business, Enterprise and Regulatory Reform
CCA	Combinatorial Clock Auction
CEPT	European Conference of Postal and Telecommunications Administrations
dB	Decibel
dBμV/m	Decibel microvolts per metre
DCMS	Department for Culture, Media and Sport
DDR	Digital Dividend Review
DSO	Digital switchover
DTG	Digital TV Group
DTT	Digital terrestrial television
DVB-H	Digital Video Broadcast – Handheld
DVB-T/-T2	Digital Video Broadcast – Terrestrial. DVB-T2 is an advanced version, currently undergoing standardisation.
EU	European Union
FDD	Frequency-division duplexing
GE-06	Geneva 2006 Agreement
GHz	Gigahertz
HD	High definition
IMT	International mobile telecommunications
JPP	Joint Planning Project
MFN	Multi-frequency network
MHz	Megahertz
MPEG	Moving Picture Experts Group

mW	Milliwatt
PMSE	Programme-making and special events
PSB	Public service broadcaster
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RRC-06	Regional Radio Conference 2006
SD	Standard definition
SKA	Square Kilometre Array
SMRA	Simultaneous Multiple Round Auction
STFC	Science and Technology Facilities Council
SURs	Spectrum usage rights
TDD	Time-division duplexing
TLC	Technical licence condition
UHF	Ultra-High Frequency
UKPM	UK Planning Model
W	Watt
WiMAX	Worldwide Interoperability for Microwave Access
WRC-07	World Radiocommunication Conference 2007